AD-A229 422

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STUDY of VEHICLE
TRANSPORTATION REQUIREMENTS
for HOSPITALS at the CORPS LEVEL

THESIS

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The opinions and conclusions in this paper are those of the author and are not intended to represent the official position of the DOD, USAF, or any other government agency.

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THESIS

Presented to the Faculty of the School of Systems and

Logistics of the Air Force Institute of Technology

Air Universtity

in Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

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September 1990

Approved for public release; distribution unlimited

Preface

This study examines the requirements for vehicle transportation to move US Army hospitals in a deployed Corps. Three MEDFORCE 2000 hospital types were studied; the Field Hospital (FLD), the Combat Support Hospital (CSH), and the Mobile Army Surgical Hospital (MASH).

Shortly after the research for this paper started, the political landscape that governs United States foreign policy and military affairs began to change. Solidity of the Warsaw Pact and the Soviet Union dissolved calling into question the probability of a major conventional war in Europe. In addition, the United States deposed the military government of Panama by force, in December 1989. While these actions do not invalidate the research of this study, they certainly increase the relative probability of US involvement in Low Intensity Conflicts (compared to a NATO/Warsaw Pact conflict) which historically exhibit lower requirements for combat service support ground mobility and greater use of permanent or semi-permanent base camps and enclaves.

This researcher used the most complete and accurate information known to be available from official sources. There may be errors in the research. Some errors are due to incorrect doctrine and data from official sources. Some errors are due to misinterpretation by this researcher (the same subject answer can differ between sources). Some errors are differences of opinion between members of the field medical support community and the military community in general. No study or recommendation will ever be 100 percent correct due to the continual evolution in doctrine, unit structures, and political/military policies.

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List of Terms and Acronyms

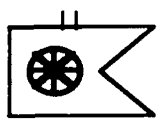
Term	Explanation
ASF	Aeromedical Staging Facility
CF	Cubic Feet
CSA	Corps Support Area
CSH	Combat Support Hospital
CZ	Combat Zone
DEPMEDS	Deployable Medical System
EVAC	Evacuation Hospital
FEBA	Forward Edge of the Battle Area
FLD	Field Hospital
FLOT	Forward Line of Own Troops
FT	Feet
ISO	International Organization for Standards
KW	Kilowatt
LB(S)	Pound(s)
MASF	Mobile Aeromedical Staging Facility
MASH	Mobile Army Surgical Hospital
MEDFORCE2000	Medical Support Doctrine 2000
MILVAN	Military-owned demountable container
MUST	Medical Unit Self-Contained Transportable
TOE or T.O.& E.	Table of Organization and Equipment
USA	United States Army
USAF	United States Air Force
USMC	United States Marine Corps

List of Terms and Acronyms (continued)

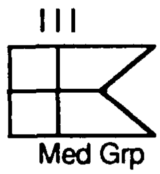
Term	Explanation
USN	United States Navy

List of Symbols

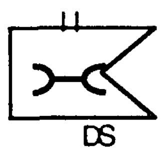
Symbol	Unit
II	Battalion size unit
III	Regiment or Group level unit
X	Brigade size unit
XX	Division size unit
XXX	Corps size unit
XXXX	Army level



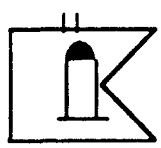
Transportation Battalion



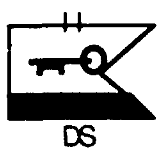
Medical Group (may control several hospitals)



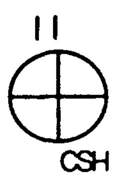
Maintenance Battalion, Direct Support



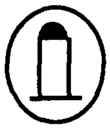
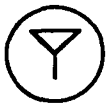
Ammunition Battalion (Conventional)



Quartermaster Battalion, Direct Support



Combat Support Hospital

Symbol	Unit
	Helicopter Landing Zone
	Ammunition Supply Point (controlled by ammo battalion)
	Graves Registration Point (controlled by Quartermaster)
	Class III (POL) Supply Point (Quartermaster)
	Clothing Exchange and Bath Point (Quartermaster)
	Class I and II Supply Point (Quartermaster)
	Casualty (used to show evacuation chain)

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Abstract

This study examines the ground vehicle transportation requirements for the three significant hospitals designated to support the deployed Corps. Under the MEDFORCE 2000 doctrine, these hospitals are the Combat Support Hospital (CSH), the Field Hospital (FLD), and the Mobile Army Surgical Hospital (MASH). This study does not consider the larger question of whether the units are properly organized or equipped as this is beyond the capability of a time and funds constrained graduate thesis.

Doctrine requires these hospitals to contain sufficient internal (organic) transportation assets to lift a given percentage of their equipment and personnel in a single lift. Under previous unit designs these hospitals were never able to meet their doctrinal requirements. With the advent of a new series of structures and new equipment, an independent examination of doctrinal capability versus computed capability has been conducted. There is still a shortfall in lift capability. Unit structure developers (Table of Organization and Equipment) have not provided sufficient vehicles to transport two of the three units at their required level of mobility.

Because the research proved a shortfall, and it is unlikely the shortfall will be made up, a computer aided decision support system (DBaseIII+) was built to help the hospital commander and staff determine or quantify their transportation shortfalls. This system allows the decision maker to apply scenario information and see the impact on the unit's transportation shortfall or overage. It is estimated that a unit equipped with this decision support system can save 12-60 man-hours developing each scenario driven ground

transportation requirement when compared to manual methods or simple computerized spreadsheets.

General research was conducted in several steps. First, a general history of field medical care was developed to inform those unfamiliar with the evolution of military medical care. Second, a more detailed history was developed covering the last two wars in which the United States has been involved; Korea and Vietnam. Third, an overview of the current doctrines, that govern employment of U.S. military ground forces in general and combat service support specifically, with emphasis on hospitals in the Corps area. Fourth, numerical data was gathered to quantify the transportation capabilities and requirements. Last, a basic computer driven Decision Support System (DSS) was developed to aide staffs and decision makers in preparing movement plans and requirements. The DSS is a potential area for further research and development.

Considering only grcss calculations and perfect capacity utilization, two of the three units meet or exceed their doctrinal requirements.

Unit	Gross Mobility: Required	Computed
1. Mobile Army Surgical Hospital:	100%	54%
2. Combat Support Hospital:	35%	46%
3. Field Hospital:	20%	44%

When the same data is calculated with an algorithm that includes consideration for less perfect vehicle capacity utilization (primarily personnel seating) only one of the hospitals meets its doctrinal requirement. Added inefficiency factors (safety, security) would cause further reductions.

Unit	Mobility: Required	Computed
1. Mobile Army Surgical Hospital:	100%	43%
2. Combat Support Hospital:	35%	24%
3. Field Hospital:	20%	25%

STUDY OF VEHICLE TRANSPORTATION REQUIREMENTS FOR HOSPITALS AT THE CORPS LEVEL

I. INTRODUCTION

General Situation

The United States Army (USA) maintains mobile and semi—mobile medical units to support combat. At the Corps level, hospitals are employed to stabilize patients for evacuation or to treat patients for return to duty. To be effective in returning soldiers to duty in the shortest time possible and treat the seriously wounded close to the point and time of injury, hospitals must be proximal to the battle. Therefore, units have a requirement to move periodically to conform to the dictates of combat plans.

For reasons of economy, many medical units are not 100 percent mobile in self—contained (organic) transportation assets. Therefore, when these units are required to displace from one location to another, the movement cannot be accomplished in one lift. Instead, the displacement requires several lifts or partial unit movements, assistance from outside transportation sources, or both. Despite the primary transport mode (rail, water, or air, excepting possibly helicopter), vehicle (truck) transport would be required at some point in the journey. Even a move from the tailgate of an aircraft to a close operational site would require some form of wheeled transport.

Transportation asset requirements to move hospitals have grown during this century. Growth in medical science capabilities and citizen expectations for quality medical care under all conditions have increased the quantity and

complexity of minimum required equipment. This generally translates into increased weight and dimensional equipment requirements (although individual items may be smaller). Any visit to a hospital laboratory or ward 20 years ago and a visit today would show a large increase in the amounts and types of equipment considered minimally necessary for proper care. These quantity, dimension, and weight factors have translated into increased requirements for transportation resources to move hospital units (developed in following chapters).

Changes in weapons and targeting technologies have increased the mobility requirement. The greater range, accuracy, and targeting capabilities of current and future weapons delivery systems have increased the requirement to displace periodically to avoid being a known or stationary target (Sayen, 1988:33, 38). Also, improvements in weapons' destructiveness have required units to disperse across larger distances (FM 90—14, 1985:4—2; FM 100—5,1986:62). These factors can create requirements for increased transportation assets driven by frequent displacements and longer trips over the increased distances (dispersals).

Changes in the tactics of opposing forces have increased the probability and lethality of Rear Area Battle (FM 90—14, 1985:1—2). Soviet combat doctrine stresses disruption of the support area and disrupting the security of individual units. Decreased security is countered by collecting units into Bases and Base Clusters for mutual defense (FM 90—14, 1985:4—2). Medical units would be included in these bases (FM 90—14, 1985:3—17). There are detrimental side effects to these bases: they create a bigger and more valuable target, create a stronger target signature (radio, thermal, and photoimaging), most area-effect weapons' burst radii would encompass the medical units in the bases (even if unintended),

and the medical units may have to use camouflage (loss of Geneva Convention markings) to conform to the tactical requirements of the other units in the base. Thus, the formation of Bases and Base Clusters increases the requirement for periodic displacement by making it more likely that the enemy will find and target the base (FM 90—14, 1985:1—6,7; Sayen, 1988:33). A medical unit cannot stand alone and defend itself. It has neither the training, equipment, nor manpower so it must move when the base is moved or abandoned (FM 90—14, 1985:3—18).

The heightened threat from chemical weapons (Libya & Iraq) has also increased the requirement for mobility and cargo capacity (FM 100—5, 1986:3). In potential Chemical Warfare environments, the units must carry changes of protective clothing, decontamination apparatus, and supplies; most items are bulky (FM 100—5, 1986:87). In the event of an attack by a persistent agent, the unit would have to evacuate the contaminated area quickly to reestablish patient treatment (ATTE—3, 1988:C—10).

Specific Problem

Do hospitals in the Corps area have sufficient organic transportation resources to conform to the doctrinal requirements for movement on the conventional battlefield?

Scope

Although there are many medical units in the Combat Zone or Corps Area, only the three principal hospital units will be considered in this study. These three units are the Mobile Army Surgical Hospital (MASH), the Field Hospital (FLD), and the Combat Support Hospital (CSH). Unit transportation requirements will be computed assuming a medium/high combat tempo such as Korea in 1950

or a potential European scenario with the potential for but no actual nuclear, chemical, or biological weapons exchange. While this level of warfare by the United States is unlikely, and hasn't occurred since 1950—51, it produces the more extensive requirement for transportation assets (AHS Paper, 1989: 1—1).

Limitation

Evaluation of the appropriateness of unit manpower and equipage as stated in the authorization documents (T.O.&E.), other than the mobility mission, will not be specifically evaluated in this study.

Research Objectives

1. Study the history of military medical care with emphasis on the period since 1950. The Korean War (1950—54) was the last time hospitals displaced to conform to a campaign of frontal movement. During the Vietnam War (1965—1975) hospitals were primarily immobile. This information provides general understanding of medical operations to help answer the Research Questions and other Research Objectives.

2. Study current and future doctrine to determine requirements for movement under the AirLand Battle concept. This helps develop Research Questions 1, 3, and 4 and is necessary to develop Research Objective 4.

3. Study and quantify current organizational structures and equipment to determine unit transport requirements and capabilities. The developed information will be compared to the doctrinal requirements to determine compliance or shortfall. This is developed by Research Questions 1, 2, and 3, plus helps answer the Research Problem and Hypothesis.

4. Develop a computer assisted decision aide for commanders and hospital staff to determine the impact on transportation requirements caused by various

mission and environmental variables for the three studied hospitals. This requires information from all Research Questions.

Research Questions

1. What equipment and personnel are in each hospital's Table of Organization and Equipment (TOE) (a standardized authorization document) and other associated authorization documents for the three studied Corps hospitals?

2. What are the weights, sizes, and characteristics of hospital equipment, for each hospital type, requiring transport?

3. Does the authorized transportation equipment for a particular hospital have the capacity to accommodate the unit's equipment and personnel and achieve the doctrinal mission mobility requirement?

Research Hypothesis

The organic transportation capability of the three Corps hospitals in this study is not sufficient to support doctrinal requirements.

Organization of Thesis

First, a general history of field medical care is included to inform those unfamiliar with the evolution of military medical care (Chapter II). Second, a more detailed history is provided covering the last two wars the United States has been involved in; Korea and Vietnam (Chapter II). Third, is an overview of the current doctrines governing employment of U.S. military ground forces in general and combat service support specifically, with emphasis on hospitals in the Corps area (Chapter III). Chapter IV describes the research methodology.

Numerical data was gathered to quantify the transportation capabilities and requirements and summarized in Chapter V. Supporting data is included in

the Appendices. Due to the quantity of data used to quantify total requirements, large data appendices are only in electromagnetic form. These appendices are available, in disk format, upon request from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

Because the hospital capabilities and requirements data is too cumbersome (extensive and time consuming manual calculations) to use at the unit level, a computer driven Decision Support System (DSS) was developed to aid staffs and decision makers in preparing movement plans and requirements (Chapter VI). Code for the computer programs is included in the Appendices (see Appendices in the Table of Contents for specific unit). Due to the lengthy programming code used in the four DSS programs, appendices are only in electromagnetic form. These appendices are available, in disk format, upon request from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

The researcher's final conclusions and recommendations are contained in Chapter VII.

II. Military Medical History

Introduction.

To better understand current doctrine (Chapter III) for field medical support, a brief history of combat medical support.is provided in this chapter.

Current service doctrinal sources and historical works have been reviewed to develop a brief history of military medical care to the present. Because it is important to place doctrine in proper context and see the path of development, a generally chronological organization is used in this chapter. This chapter is divided into two parts; a general information section covering the period from the Roman Empire to 1945 , and a section covering the period from 1945 to 1973.

General Reasons for Medica Support.

One of the keys to effective maintenance of military force manpower levels is an effective medical service (FM 8-20, 1983:1-2). The more professional or trained a force is the more important it is to preserve the investment of time and resources required to bring individuals and the unit to a trained and effective level.

Medical Support to combat operations can be broken into several categories; two are important here. The first category is evacuation and initial treatment with the goals of stabilizing a casualty and removing him from the battle, steadying the morale of the other troops, and preventing other troops being diverted to take care of their buddy. The second category is the definitive treatment of serious wounds (hospitalization) with the goal of treatment within the Golden Two Hours (1-3 hours) beginning with the instant of traumatic

injury. It is important to quickly initiate treatment to achieve the highest level of patient survival, minimal limb and sight loss, and speed recovery. Achieving this goal requires forward treatment, keeping pace with the battle, rapid evacuation, and relatively near hospitalization (TRADOC 525-50, 1986:3).

Military Medical Care - Roman Empire to 1945

Roman Empire. The first well documented military medical service was in the Roman Imperial Army at least 2000 years ago. Imperial Roman depended on intensively trained long service soldiers to man their legions. To preserve their investment and to maintain a ready and effective force, an organized medical service was developed. In capability and organization, this medical service probably surpassed European medical practice until at least the 1850s (O'Connell, 1989:80). It isn't apparent whether there were portable hospitals in the legions, but the legions were consummate and speedy builders and evidence of heated and sanitary hospitals are found across the old empire. Each legion, when in semipermanent or permanent camp, established a hospital of about 60 five bed wards (300 beds) for a legion with the strength of 4000 to 5000 men (Webster, 1985:200-201). A legion is roughly comparable to the current US Army brigade which might have about 200 beds in support. The Roman medical corps was divided into two basic groups. First, were the *medici ordinarii* of officer rank who, apparently, were trained physicians and signed up for the training experience and only a limited period of service. Second, were the *immunes* and *capsarii*, equivalent to long service enlisted specialists or corpsmen (Webster, 1985:259). This division between short service doctors and long service enlisted technicians closely parallels the same situation today. Trajan's victory column in Rome depicts the operations of these medical personnel. The system wasn't

perfect; the normal division of casualties in battle were slightly wounded, clean amputations, and soon-to-die. Infection was a continual problem until the use of antibiotics began in World War II.

Byzantine Empire. After the Roman Empire decay in the 3-5th Centuries A.D., the Byzantine Empire, in the eastern Mediterranean, continued the Roman military organization until at least the 7th Century. It is recorded that Byzantine Armies included a medical corps of surgeons and stretcher bearers in their battles with the Arabs during the Muslim expansion out of the Saudi Arabian peninsula (Glubb, 1980:139-140). Existence of medical services and other elements of an immobile logistics tail contributed to the defeat of the Byzantines by the unfettered Arab nomads in most battles after the initial Arab defeat at Mota in 629 A.D. (Glubb, 1980:139-140).

Middle Ages. In Europe, after the disintegration of the Roman Empire, medical service became disorganized or nonexistent until national armies started to develop in the 14th or 15th Century (O'Connell, 1989:110-123). Nobles of the Middle Ages might be accompanied by personal medical personnel but no specific care was provided for the lower ranks. An incapacitating wound on the battlefield usually meant death from infection, exposure, or looters until the late 1800's. Religious orders provided an occasional semblance of medical care, Knights Hospitalers are an example (Columbia, 1975:1737). Barbers were common providers of medical care because they had sharp instruments and blacksmiths provided some treatment because they had experience with animal care (as in *Don Quixote-Man of LaMancha).*

Age of Reason. As the professional standing army began to reappear in Italy in the 15th Century, the investment in trained manpower required provision of a level of medical care support to preserve that force. The closest

precursors to the the American development of medical care were from the French and British Armies. The Duke of Marlborough (Churchill) apparently began development of a systemized evacuation system at the beginning of the 18th century and by 1718 the French had improved upon those efforts (Huston, 1966:14). The British adopted the French system and used it in 1745. They had a system of fixed and mobile hospitals in use by 1748 (Huston, 1966:14). One of the earliest acts of the Continental Congress in the Revolutionary War was the establishment of an army medical service in 27 July 1775 (Huston, 1966:14). In quality, the Roman Army medical service of a thousand years earlier probably remained superior to these European and colonial medical services (the Roman hospital design exhibits an understanding of germ theory) (O'Connell, 1989:80). Continental Army hospitals were not well thought of initially. However, with the appointment of Doctors Rush, Jones, and Tilton conditions and organization improved greatly, especially considering the lack of funds in Washington's army (Huston, 1966:40). While germ theory hadn't been discovered yet, the three doctors initiated crude smallpox inoculations (required by Washington after 1777), segregation of diseases, and reduced overcrowding (Huston, 1966:40-42).

After the conclusion of the Revolutionary War, the organized medical services were allowed to disappear (the Army almost disappeared too) with local commanders responsible for providing medical care. For several years soldiers paid for medical care through deductions from their pay until this was stopped in 1792 (Huston, 1966:100). A Medical Department was briefly restored in 1798 for two years during a war scare with France and then disappeared until the War of 1812 finally established medical services as a permanent and central function of the US Army (Huston, 1966:100). The War of 1812 was generally a

military fiasco for the United States, particularly in the beginning. Medical care was no better than 30 years earlier in the Revolutionary War and there was not the excuse of weak Continental Congress (Hickey, 1989:78-9).

Napoleonic Wars. Since the fall of the Byzantines, the French developed possibly the best systematically organized treatment and evacuation system under Napoleon (Elting, 1988:281-287). There were a number of reorganizations beginning with the national draft decree of August 1793 but nothing effective was developed until 1813. Then a fully military organization was developed that included aid stations at the regimental level, designated stretcher bearers, ambulances, and several levels of hospitals (Elting, 1988:281-287). All levels were required to be mobile. In theory the organization was well developed but the implementation was hit or miss with variations in quality from unit to unit (Elting, 1988:281-287). The system didn't have time to fully mature because Napoleon was defeated in June 1815. A comparison of the Napoleonic French system and current system of evacuation and increasingly sophisticated levels of care show considerable similarities. The British Army also adopted a thoughtful medical system at this time but after Waterloo the system was abandoned (Farwell, 1981:180).

Wars of 1846-1859. Even with the obvious preventable waste of manpower caused by poorly organized medical systems, the lessons from the Napoleonic Wars were not quickly applied. The lack of medical organization was repeated in the Mexican War of 1846-48, the Crimean War of 1853-56 (Columbia, 1975:683 & 1943; Farwell, 1981:180-81), and the Battle of Solferino in 1859 (Turnbull, 1985:157). Some of the medical care for US Forces in Mexico was provided by contract civilian physicians due to the inadequate size of the Medical Department (Huston, 1966:135). Lack of plans or organization for an

adequate medical care structure for military forces to retrieve and treat wounded caused Henri Dunant to form the Red Cross in 1863 (Columbia, 1975:2288).

United States Civil War 1861-65. It has been said by many that the Civil War was the first modern mass war (O'Connell, 1989:197). Added to the mass armies of Napoleon were the use of rifled weapons, electronic communications (telegraph), and mechanized transportation (railways) (O'Connell, 1989: 197).

Medical care began poorly in large part because the U.S. Army expanded too rapidly from a small frontier force for the existing Medical Corps to accommodate the growth. Reforms were begun by Surgeon General Hammond and Jonathan Letterman in 1862 (Huston, 1966:241). It took until 1864 for all of the improvements to be incorporated through out the army (Huston, 1966:243). By the time of the battle at Gettysburg, July 1-3, 1863, a system similar to the Napoleonic form was in place. This basic system of forward treatment stations, dedicated ambulance wagons, enlisted medical personnel, and hospitals at the division or corps level remained the standard for for the next 40 years (Huston, 1966:240). Unfortunately, medical care was still looked upon as a drag on the army by many officers (still a problem today) (Hoffsommer, 1963:37). In general, each regiment would be served by an aid station just behind the lines. At this point casualties were treated and returned to duty or evacuated further to the rear to division hospitals (for surgery) out of cannon range, and then to corps hospitals for recovery until well enough to be moved to permanent hospitals or returned to duty (Hoffsommer, 1963:37).

In the Battle of Gettysburg, it took two days, late on 2 July, for the first corps hospitals to arrive and set up to receive casualties because hospitals had been excluded from the wagon train in the rush march to the battle

(Hoffsommer, 1963:37). For those first two days of battle, casualties had to be cared for by makeshift means and the limited facilities of the battalions and regiments (Hoffsommer, 1963:37). About 8 July casualties were being shipped out by train from the corps hospitals to various cities and by 18 August most of the hospitals had been dismantled (Hoffsommer, 1963:37).

An important development in the Civil War was the specially designed ambulance wagon (Huston, 1966:243). This wagon was an improvement on the ambulances of the Napoleonic Wars and was designed to provide the most comfort possible to casualties. The design remained in service into the 1920's and was popular on the frontier because it was well sprung (photographs of post WWI use are located at Fort Sam Houston, Texas). Dedicated hospital boats and trains were also developed during the Civil War (often fought by the Quartermaster General) to transport the injured from the mobile hospitals to the permanent hospitals (Huston, 1966:244-6). Much of the medical care during the Civil War was still provided by charitable organizations (as during the Crimean War) and there still was no general organized system for collection and burial of dead (Hoffsommer, 1963:35-38; Columbia, 1975:239).

The Civil War did finally bring to public awareness the great need for a systematic way to care for the dead. Possibly the first large scale organized collection, identification, and burial project was directed at the end of the war.

Use of anesthesia (ether) for battlefield surgery was introduced and increasingly used during this war (Columbia, 1975:102). Hospital Mortality rate was down to 8 percent for the Union Army for the period 1861-65, better than the French experienced in the Franco-Prussian War in 1870 (Huston, 1966:251-2). At about the same time as the Civil War, several important advances were made in medical science; Pasteur discovered bacteria in 1858, Lister linked

bacteria to wound infections and used antiseptics in 1864, and Pasteur and Koch linked bacteria to specific diseases and infections in 1876 (Huston, 1966:251). Neither the military or civilian medical systems paid quick attention to these developments.

Spanish-American War. The Spanish-American War (1898) in many ways repeated the beginning mobilization phases of the Civil War, rapid growth and little control. The rapidly expanded army was poorly formed and only the rapid ending of the war prevented large scandals due to unpreparedness (Huston, 1966:290). There was only one military general hospital in existence prior to 1898 and it was located at Hot Springs, Arkansas, with a capacity of 80 beds (Huston, 1966:255). The opening of the hospital coincided with the formal establishment of an enlisted medical personnel organization.

Casualties due to disease exceeded those from battle (Columbia, 1975:2587). The rate of battle deaths to disease was about 1 to 10. Some of this was due to tropical disease but much of it was caused by typhoid that had been successfully controlled in the Regular US Army since the later part of the Civil War (Huston, 1966:289-90).

An important outgrowth of this war was a greater understanding of disease spread through insect vectors (malaria and yellow fever). Disease and insect control was extremely important to the U.S. success in building the Panama Canal (Columbia, 1975:2055). Militarization of women nurses began with this war (Huston, 1966:255).

Boer War. On the heels of the Spanish-American War was the Boer War (1899-1902) in South Africa. This war presaged World War I with use of trenches, pillboxes, and automatic weapons. Despite the scandals of poor medical care in the Crimea and experience of almost continual colonial wars, the British

medical department failed in this war (Pakenham, 1979:402-404; Columbia, 1975:683). Various inspectors and journalists found the charitable/volunteer hospitals well equipped but the army hospitals doing more harm than good. There were organized medical evacuation units and hospitals but lack of command interest doomed them to failure (Pakenham, 1979:403).

World War I 1914-18. By the beginning of World War I (WWI) in August 1914, infection prevention techniques and immunization were understood and generally practiced on the Western Front of Europe (Columbia, 1975: 1409, 1591, 2079). Due to the huge masses of casualties from automatic weapons, artillery, and chemical weapons, the treatment system was often under strain. But, generally, once a casualty could be evacuated out of the battle area trenches, treatment was thorough and fast. It was possible for British soldiers to be in England within two days of evacuation from the battle. From 1915 until 1918 the front was basically stalemated. Stabilized front lines meant that the rear areas could be extensively developed and hospitals could be relatively immobile (similar to Vietnam) (Keegan, 1976:266). This reliance on fixed facilities became a problem in mid 1918 when the Western Front finally began moving. The lack of mobile hospitals required the wounded to be transported long distances over damaged or nonexistent roads to the fixed hospitals (Huston, 1966:379).

Truck body ambulances made their first mass appearance in World War I. Use of blood transfusions and replacement fluids were begun for the first time on large numbers of people (Keegan, 1976:266). However, identification of Blood Groups was not until about 1929 and Rh factors was not until 1940 (Columbia, 1975:1525). Antibiotics were not yet in use (Columbia, 1975:2097).

World War II 1939-45. Among the key aspects of World War II (WWII) compared to WWI and earlier wars were the dispersion of units, the increase in firepower, and the increased maneuverability of the armies (Dyer, 1985:80-88). Mechanization of war made it more dangerous. Previously wars (like farms) were governed by the endurance of draft animal power. Mechanization greatly reduced the constraints on the length of battles and the speed and range of campaigns (Keegan, 1976:303). As the weapons improved in range and accuracy, forces spread out and became more mobile to avoid being targeted (Keegan, 1976:310). Compared to previous wars, when large units could lose better than 50% of their personnel in one day, WWII casualty rates averaged about 2% a day at the division level (Dyer, 1985:143-144). Individual units could be wiped out but these were usually small units, not the battalions and regiments lost in WWI and previous conflicts. The problem was that now battles continued for weeks, instead of 1 to 7 days, increasing the total exposure to potential death or injury (Dyer, 1985:143-144). Obviously, high levels of wounding require extensive medical support and evacuation, and the flow of battle requires the medical treatment facilities to keep pace with the units.

Pacific Theater. The island hopping campaigns made extensive use of offshore hospital ships. The onshore hospitals only moved occasionally because the size of the islands didn't make moving necessary to remain in contact with the battle. The battle on Luzon was probably the only campaign on an island big and open enough to require ground movement of hospitals.

European Theater. It was a different situation in Europe. The size of the continent required a well developed evacuation and hospital system. In the Corps area the medical units and hospitals had to be mobile to keep pace with the battle. With the massive mechanization of armies daily advances of 30

or more miles a day could be achieved (Keegan, 1976:290-291). At division level, the Medical Regiment operated a clearing station/hospital and sent forward medical teams to the combat regiments, teams, and battalions. These medical teams treated and stabilized casualties and sent them back to the division rear where the casualties might be further evacuated to a corps level hospital. Initially the medical support at corps level was based on the experiences of WWI where mobility was less of a requirement compared to WWII. In 1941 there were two main types of corps hospitals. First, a 400 bed surgical hospital, that contained a detachable mobile surgical team, with the capability of splitting into two smaller hospitals. Second, was a 750 bed Evacuation Hospital (EVAC) with no organic mobility (Bigham, 1969:B-7&8). It was found during the North Africa campaign that these units were not able to keep pace with the battle. The EVAC was modified to become a 400 bed semi-mobile unit and the surgical hospital was eliminated (Bigham, 1969:B-7&8). A Field Hospital (FLD) of 380 beds was also developed to care for troop populations in rear areas and contained little surgical or mobility capability. This hospital had the capability of dividing into three 100 bed hospitals. The FLD was used extensively in the European Theater in its designed role and also as a forward surgical hospital when supplemented with extra surgical teams and vehicles (Bigham, 1969:B-7&9).

The major advances of WWII were expanded use of blood plasma and replacement fluids, and early antibiotics. In general, if the casualty lived to reach the hospital the patient survived because of antibiotics, improved techniques and blood replacement. The average time from time of injury to arrival at the aid station was one (1) hour (Keegan, 1976:269-270). Some evacuation use of airplanes and primitive helicopters was made but most casualties traveled by vehicle, train, or boat.

General History and Doctrine 1945 to 1973

Several points are common throughout the last thirty to forty years of development in medical unit design and medical support discussed in the follow-on sections. First, the continual advance of medical techniques and equipment has enabled greater life saving of seriously wounded personnel. Second, rapid evacuation has delivered alive but seriously wounded personnel to the hospitals that require the new life saving techniques and equipment for survival. Third, success in saving lives has justified more equipment further increasing the weight, size, and complexity of hospital units thereby reducing their mobility. This decreasing mobility of hospitals has developed while mobility of combat units has continued to increase.

Medical Units in Combat 1950-1973

Post War Reorganization. Following WWII, medical support for combat was reorganized at both the division and corps level. One of the lessons learned from WWII was the need for greater flexibility in providing medical support to both large and small combined arms teams (e.g. infantry and armor)(Cowdrey, 1987:74).

It was decided to reduce the size of the division level medical unit from a regiment to a battalion and integrate much of the medical support into the combat regiments and battalions. The new structure provided an aid station staffed by a doctor in each combat battalion with some aid station personnel working forward with the platoons and companies as aid men, litter bearers, and ambulance drivers. This level had to be as mobile as the unit it supported and held patients only long enough to arrange rearward transportation. At the regiment level, a medical company provided a clearing station and ambulances

that collected the casualties from the forward battalions. The division medical battalion in turn operated a clearing station and gathered casualties from the regimental clearing stations. Depending on the wound and evacuation assets available, the casualties might bypass intermediate levels and go directly to the supporting corps hospital (Cowdrey, 1987:74). This new medical support system was soon tested in Korea.

Corps level medical units were also reorganized after WWII to correct perceived deficiencies in medical care. The EVAC received extra staff and the Mobile Army Surgical Hospital (MASH) was created as a 60 bed mobile hospital to closely support divisions. The FLD hospitals were enlarged slightly to 400 beds but were still organically immobile (Bigham, 1969:B-10).

Korea 1950-54. The first medical support units arrived in Korea from Japan by aircraft and ship in June 1950 and moved north to support US Forces in the Osan-Taejon area (Cowdrey, 1987:74-75). Because enemy infiltration was common in 1950, the clearing stations were normally established within the perimeter of a combat unit and close coordination maintained to ensure the medical company was ready to move with the combat unit and avoid being left unprotected (Cowdrey, 1987:75). Clearing stations were supported by a nearby Corps level unit such as the MASH at which more detailed surgical procedures were performed. Because the Korean War was a United Nations action U.S. hospital units were responsible for care of many nationalities and services (Cowdrey, 1987:88).

By doctrine, one MASH supported one division, but in practice the MASHes supported two or more divisions(Cowdrey, 1987:88). Supporting the MASH units was the Evacuation Hospital (EVAC) further to the rear of the battle lines. The MASH was supposed to transfer its patients to the EVAC as soon as they were

stabilized and was designed with a bed capacity of 60 patients. In practice, once a MASH was established in a location its staff and bed capacity grew and until it acted more like an EVAC (Cowdrey, 1987:89). Transport of wounded between the MASHes and EVACs was primarily by ground ambulance and train. Contrary to current impressions, helicopter air evacuation was not the primary means of evacuation from the front to the MASH (it was the preferred means) (Cowdrey, 1987:167). A study in August 1950 found that 88 percent of the wounded received medical care within two hours of wounding (Cowdrey, 1987:88).

At the Army or Communications Zone (COMMZ) level were the General Hospitals in Japan with evacuation between Korea and Japan primarily by plane (Cowdrey, 1987:79).

By August 1950, four MASH, three EVAC, and two Field Hospitals were in Korea (Cowdrey, 1987:99). With the September 1950, Inchon landings and the breakout of United Nations forces from Pusan, movement of hospitals became hectic. In October 1950 the 8055th MASH displaced from the Pusan area, to Taegu, to Taejon, to Ascom City (Inchon), to Pyongyang, North Korea, about 300 air miles but about 2-3 times that distance on primitive dirt roads (Cowdrey, 1987:107). The 8076th MASH left the Pusan area and ended up in Haeju, North Korea. During the September to October period the MASHes moved about every 3-5 days until they reached North Korea (Cowdrey, 1987:105-108).

Once in North Korea, the combat units marched north at a rate of about 15 miles a day (Cowdrey, 1987:109). This pace required the mobile hospitals to move about every 2-4 days to remain in contact with the advancing units, about 50-100 miles. To some extent, the MASHes remained in place until an EVAC or Field Hospital caught up to them and took over their patient load, then the MASH would move forward again. During the rush north above the 38th Parallel,

evacuation was primarily by airplane from the forward hospitals to the rear due partly to the distances to the EVACs in the Seoul area, no functioning railroads, and the low number of casualties (Cowdrey, 1987:111). Action on the east coast of Korea was somewhat slower and fewer units were involved, but the evacuation routes were much longer. MASH units reached within 50-75 miles of the Chinese border before the United Nations retreat started just after Thanksgiving 1950 (Cowdrey, 1987:123). A combination of US Army and US Navy medical units and hospital ships were used to support the east coast combat units (Cowdrey, 1987:125-126).

By 30 November the MASHes were pushed south, back to Pyongyang. The 64th Field Hospital was moved out of Pyongyang (by train) to make room for the MASHes. By 14 December the 64th was on a ship out of Inchon returning to Japan (Cowdrey, 1987:124). MASHes evacuated the Pyongyang area by 4 December and headed south to the Seoul area and were there by the end of December. On the east coast, the MASHes and EVAC were evacuated and loaded on board ships by 19 December. All units were evacuated and the port of Hungnam was blown up on Christmas Eve (Cowdrey, 1987:126). By mid January 1951 the Chinese had pushed the UN forces south of Seoul (Hastings, 1987:347).

In mid February 1951, the UN forces started their push back north. Between January and May 1951 the MASHes were moved about every two weeks to keep pace with the battles against the Chinese in the new drive north. Due to the large surges in casualties and a sometimes interrupted evacuation chain, the MASHes varied from their designed 60 beds up to about 200 beds (Cowdrey, 1987:168). Between January and April 1951, the 121st EVAC relocated back and forth between Taegu and Seoul, as the battle lines oscillated, averaging a move about every 3-4 weeks (Cowdrey, 1987:168).

Later in 1951, the front stabilized and by 1952 there was a draw- down in the number of in-country EVAC hospitals. All the hospitals (EVACs, MASHes, FLDs) became more permanent and moved into buildings for at least some of their functions. By late 1952, the 8th Army Surgeon remarked that "few, if any, individuals have seen the units moved" (Cowdrey, 1987:204). From 1952 to the armistice, the hospital support to the combat units remained mostly a fixed site area support system (Cowdrey, 1987:203-204).

The combat zone medical support system developed after WWII and modified slightly in Korea was continued into the 1970s. The major change was the increased use of helicopter evacuation in preference to ground ambulances (Bigham, 1970:C-6)

Vietnam 1965-1973. US Army medical units began deploying to Vietnam in 1965-66. Initially most of the units were under canvas and consisted of MASHes, EVACs, and Field Hospitals. Unlike the linear fronts of Europe in WWII and Korea, the war in Vietnam didn't have a front line with the support units in echelon behind the lines. Vietnam was characterized by permanent enclaves supporting combat units that commuted to the battles. Support units did not usually move. "The hospitals did not follow the advancing army in direct support of tactical operations" (Neel, 1973:59). Hospitals (MASHes, EVACs, and FLDs) were stationed inside these enclaves and rapidly converted from tent units to semipermanent or permanent air conditioned facilities ranging from wood buildings, Quonset huts, to concrete and brick multistory buildings. Casualties were often flown directly from point of injury to the hospital bypassing the battalion and division level treatment facilities. "Since there was no secure road network in the combat areas of Vietnam, surface evacuation of the wounded was almost impossible" (Neel, 1973:59). Corps level hospitals grew into an immobile

stateside quality medical system. Most movements of hospitals were to support changes in division stationing (1968) or upon deactivation of units (after 1969) (Neel, 1973:63). The medical support unit was generally transported by air or sea to the new location (Neel, 1973:61).

Often, movement to a new location generated the construction of air conditioned hospital facilities, considered a requirement in Vietnam (sweaty patients are prone to wound infection and slower recovery). To fill the gap between arrival of the hospital unit and completion of construction, a new type of hospital equipment was developed. The first air conditioned inflatable hospital arrived in Vietnam in 1966 (Neel, 1973:65). Designated the Medical Unit Self-Contained, Transportable (MUST) the hospital consisted of a series of interconnecting inflatable Quonset huts and expandable (trailer like) boxes which were provided air conditioning and other utilities by several gas turbine powered utility units. The first unit was considered a success and ultimately five units were equipped with MUST equipment. The Transportability feature was never exploited in a tactical sense and it was apparently an effort to have units maintain their field equipment once they had moved into their newly constructed permanent quarters (Neel, 1973:67). One possible reason for difficulty in maintaining the equipment was its susceptibility to shrapnel. By 1970 all the MUST equipped units had either been redeployed to the United States, moved into permanent facilities, or deactivated (Neel, 1973:68).

Static siting of hospitals, combined with the one year tour, bred out the art of campaigning from medical units and other nondivisional support units. "Proximity to tactical operations was a consideration only in the sense that the hospital had to be within reasonable air-evacuation time and distance" (Neel,

1973:68). Direct transport of most casualties by helicopter, allowed by US air superiority, eclipsed the doctrine of ground evacuation necessary for survival in situations with no air superiority (Neel, 1973:59).

Advances in medical care produced within and outside the military created a large technologically complex hospital. "In essence, hospitalization in Vietnam combined that normally found in the communications zone with that found in the combat zone" (Neel, 1973:174). Due to rapid evacuation (1-2 hours from injury to hospital) and capable hospitals, the mortality rate was extremely low (97.5% survived) (Neel, 1973:70). Unfortunately, the success of the medical system under the special circumstances in Vietnam created a medical system unusable on the mid to high intensity battlefield. It has taken 20 years to begin weeding out the mindset of the Vietnam hospital system and replacing it with a system capable of surviving on the envisioned mobile battlefield.

Developments in Equipment WWII to Vietnam

As medical science has developed new equipment, the U.S. military has tried to integrate it into its medical care system. This integration is driven by several factors, two being the infatuation of medical personnel with modern equipment and the public's expectation of high quality care in all situations. This expectation is carried into the field medical care system creating larger, more complex, and less mobile combat zone hospitals (US Congress,1979:99-100).

World War II and Korea brought the use of X-ray machines, refrigerators, basic laboratory equipment, whole blood and blood products, and antibiotics to the combat zone. Vietnam continued improvements in these areas and added the desire for climate controlled surgical areas and recovery wards. Current trends

in field medical equipment design continue the transfer of fixed facility diagnostic equipment to the field.

The WWII and Korea combat hospitals were tent designs and relatively transportable by truck (2-4 men can load a large tent on a truck). The Vietnam War introduced the air conditioned MUST hospital. MUST's are packaged in 30 or more multipurpose expandable hardwall shelters (about 12 feet long by 8 feet high by 7 feet wide) weighing up to 10000 pounds when packed (Boyd,1984:10). In an attempt to modernize the 1960s MUST equipment and standardize tri-service medical care, the new 1980s Deployable Medical System (DEPMEDS) is replacing the existing MUST equipment.

Historical Conclusion

Historically the type of warfare, force structure, technology, and medical care expectations have driven the shape of combat medical support. Simultaneous advent of mechanized warfare, increasingly sophisticated medical care, and public expectations have placed two forces in conflict. On one side is the necessity to remain mobile to conform to the requirements of the battlefield. On the other side is the desire to provide the best and most modern medical care to the combat zone, even though the achievement of a high level of care creates a heavy possibly immobile hospital. The history of US Army combat medical care in the last 30 years indicates a trend away from mobility despite the supported combat arms becoming more mobile. Further study needs to be conducted to determine if the medical unit immobility trend has been arrested and corrected toward conformity to the requirements of the mobile battlefield.

Figure 1 (following pages) depicts the notional relationship between the variables of probability of conflicts and levels of violence in combat to the

transportation requirements for support units. The first year of the Korean War (1950-51) and the last six months of war in Europe (1944-45) would be considered mid-to-high intensity combat with requirements for support units to move often to maintain contact with the unfolding battles. The Vietnam War was characterized by fixed fortified base camps from which support was provided to dispersed fire support bases and scattered units (low-to-mid intensity). The later years of the Korean War (1952-54) and WWI, while certainly mid-to-high intensity conflicts, were characterized by fixed linear fronts and relatively fixed and developed support areas.

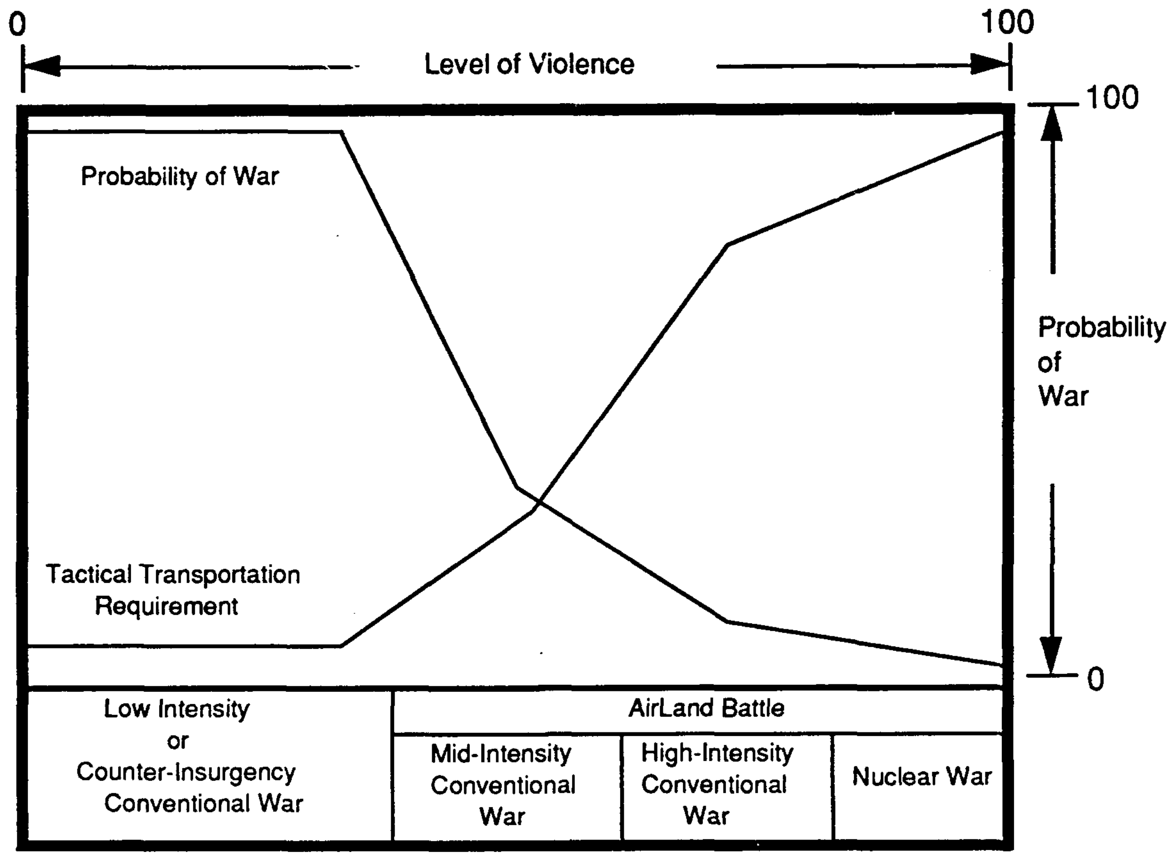

Figure 1. Spectrum of Conflict
(Adapted from AHS White Paper, 1989, page 1-1)

III. Current U.S. Army Doctrine

The U.S. Army maintains a system of portable hospital facilities to support combat operations. To be effective, these units must be mobile to keep pace with the battle and reduce casualty transportation to a practical minimum. This chapter describes the current AirLand Battle Medical Support Doctrine, the proposed in MEDFORCE 2000 doctrine, other doctrinal sources, and unit and equipment evaluation studies.

In its simplest form the traditional required doctrinal tasks for a unit in combat are to be able to MOVE, SHOOT, COMMUNICATE, and SUSTAIN. Current AirLand Battle doctrine has expanded, mixed, and renamed these basic requirements but these are easiest to remember and use as a backbone for other doctrine. AirLand Battle doctrine tenets are: initiative, agility, depth, and synchronization (FM 100-5, 1986:15). An important element of combat power is sustainment. The key sustainment functions are: man, arm, fuel, fix, transport, and protect. Support units use different proportions of these basic functions to perform their designed missions (for example a hospital unit performs primarily manning) (FM 100-5, 1986:61). It can be seen that the tenets and functions support the four basic tasks. Past experience has shown that medical units, and particularly hospitals, have not been able to fully accomplish some of these basic tasks with only their authorized personnel and equipment (Bigham, 1969:B-17). This study will determine if the new series of organizational structures can accomplish the MOVE task according to doctrinal requirements. It must be realized that all of the four basic tasks, the tenets, and functions are interrelated (FM 100-5, 1986:12).

AirLand Battle Doctrine

AirLand Battle doctrine is the Army's capstone doctrine for generating and applying combat power at the operational and tactical levels (FM 100-5, 1986:14). Beginning in the early 1980s this combat doctrine was developed for the AirLand Battlefield of the 1990s. AirLand Battle doctrine envisions a very large fluid battleground without fixed lines. It will not be possible to assume a certain airspace is safe or to distinguish linear battle lines (Russ, 1988:13). Combat units will coalesce at specified points to conduct an attack and then disperse to avoid presenting a mass target. Some units, particularly rotary wing aviation, will penetrate 30-60 miles into the enemy area to fight/disrupt his follow-on and support forces. In return, the enemy is expected to penetrate the US rear areas to disrupt our support structure. Remote targeting of units by enemy artillery and rockets is expected based on the radio and heat signatures of headquarters and support units. Extensive radio jamming will prevent or impair rapid coordination and evacuation.

Tenets of the AirLand Battle doctrine are: initiative, agility, depth, and synchronization (FM 100-5, 1986:15). Initiative requires that the battle be fought in a rapid manner keeping the enemy off balance using all the assets at the disposal of the commander. Agility applies to both mental and physical ability to react quickly to developments in the battle to retain the initiative. Depth applies to the requirement to conduct combat in the whole battlefield both forward and to the rear of the the forward line of contact. This allows the commander the maximum space and time to achieve initiative and retain agility. Finally, Synchronization is the proper coordination of all of the commander's assets to achieve initiative, agility, and to fight in the full depth of the battlefield keeping the enemy forces in the weakest position possible. All four

of these tenets place emphasis on the mobility of combat units. Sustained mobility of combat units is only possible if the sustaining support units can remain in contact to support combat operations.

AirLand Battle sustainment is the task that allows the commander to realize a combat unit's power potential and continue the use of that potential. There are six basic sustainment functions; manning, arming, fueling, fixing, transporting, and protecting (FM 100-5, 1986:59-61). Medical support units are concerned about all of these functions for their own continued battle effort, but primarily the manning function as it is the medical support system's task to conserve the combat manpower strength through prevention and cure of disease and injury (FM 100-5, 1986:61). Medical support must be continuous and proximate in support of combat operations (Bigham, 1969:B-1,2). This places in conflict the hospitals' need to be established to provide medical care and mobility to remain close to the location of injury. Once a hospital is established and receiving patients mobility is lost. The only way for the medical system to remain proximate in a fluid battle (taking into consideration evacuation assets available) is for hospitals to displace in echelons (leapfrog) by handing off patients and treatment to other facilities before dismantling and moving (Bigham, 1969:B-1,3). The requirement for continuity also requires that a hospital can not completely close until all patients have been discharged or transferred (Bigham, 1969:B-3) nor can all hospitals close at the same time.

Driving the required shifting of combat service support units is the movement of divisional and brigade combat units conducting operations. Corps level units must remain in supporting distance of the combat units' support organization such as Forward Support Battalions (FSB) and Main Support Battalions (MSB) which are in close support of the forward units. As tne FSB and

MSB shift with their combat units, corps units must usually displace. One estimate is for the MSB displacements to be every three to five days for a distance of 75 kilometers (Dail, 1990:48-49). Corps level hospitals would usually have the option of displacement at the same time (during an advance) or to leapfrog hospitals. An immediate displacement would need to be on the same schedule as the MSB for about the same distance. Leapfrog movements of hospitals could delay the requirement to move but increase the distance to move by how much the MSB had moved since the hospital's last displacement. It should be obvious, that both frequent moves for short distances and less frequent move for greater distances exact a time penalty in lost medical treatment capability.

There are concurrently several medical support doctrines in existence, (an overlap of outgoing and incoming doctrines).

Medical Support Doctrine 1975-1989

Medical support doctrine is currently in flux. Most published U.S. Army doctrine (Field Manuals) is dated from mid 1970 to the early 1980s. In the last five years new medical support doctrine to support the AirLand Battle has been published for school use and these texts are sometimes in conflict. Additionally, a new doctrine or concept, MEDFORCE 2000, is in development for the 1990s.

The United States Army (USA) when deployed in a theater of operations is composed of several combat support echelons the organizational structure depending on the size of the force and the mission. The organizational levels from higher to lower are the Theater Army, the Corps, the Division, the Brigade, and the Battalion (FM 100-5, 1986:183-187). The goals of medical treatment at

each level are to return personnel to duty in the least time possible and to treat personnel as close to their unit or point-of-injury as possible.

At the highest level is the Theater Army (TA). The TA may not be employed if the contingency is small and the requirement can be satisfied by a Corps or Division. When the theater is sufficiently large and the span of control over units requires formation of more than one Corps, a Theater Army will be formed. "The TA has both operational and support responsibilities" (CGSC-ST 63-2, 1988:2-7). Furthermore, "the TA has no fixed organization" (CGSC-ST 63-2, 1988: 2-7), it is developed and modified to meet the operational demands of the theater. The area the TA Echelons Above Corps (EAC) units occupy is termed the Communications Zone (COMMZ). In general, the COMMZ contains few ground combat units and a preponderance of support units. Medical units are generally in area support and include supply and maintenance units, ambulance units, Station Hospitals, clinics, and General Hospitals (AHS Paper, 1989:1-16). The General Hospitals are similar to large medical center hospitals found in many metropolitan areas offering a complete range of services. Patients whose estimated recovery time exceeds the Corps Evacuation Policy but not the Theater Evacuation Policy will be evacuated from lower Corps level facilities to TA facilities in the COMMZ. Patients who exceed the TA evacuation policy (for recovery) may bypass the TA facilities and travel direct to the United States (FM 8-10, 1978: G-3).

The Corps Area is the primary focus of this study and the Corps is the primary unit in the Combat Zone. Most of the units at this level and below have some direct part to play in the tactical operations of the Corps and therefore require some degree of mobility. A Corps is the smallest ground force level of organization (2 to 5 divisions) that contains sufficient combat, combat support,

and combat service support (including medical) units to conduct sustained operations (FM 8-20, 1983:4-1).

The rear boundary of the division or forward boundary of the Corps Support Area (CSA) may be roughly defined as the maximum range of enemy artillery. The rear boundary of the Corps is roughly the maximum range of short range rockets. The forward boundary of the combat zone is roughly defined as the line of contact with the enemy and termed the Forward Edge of the Battle Area (FEBA) or Forward Line of Own Troops (FLOT) (AHS Paper, 1989:2-4,5). Thus, Corps units are subject to fire at any time. Figure 2 depicts a notional or hypothetical battlefield that summarizes relationships between the various levels of organization of the US Army in the field.

In the CSA are various medical units and the this is the lowest level that provides hospitalization. The Division and the separate Brigade/Regiment level do have minimal holding capacity for minor illness and patients awaiting evacuation, less than 72 hours. Corps level hospitals include the Mobile Army Surgical Hospital (MASH), the Combat Support Hospital (CSH), and the Field Hospital (FLD) (AHS Paper, 1989:1-16). Corps medical units have two basic missions; relieve the divisions and brigades/regiments of longer term medical care so they can remain mobile, and provide health care to Corps units (FM 8-20, 1983:4-1).

The general plan of evacuation in the Corps is for casualties to be forwarded from division level to a MASH, CSH, or EVAC. Doctrine in FM 8-20 called for patients to feed directly into any of the three units with the EVAC providing back up to the first two for more serious cases and overflows.

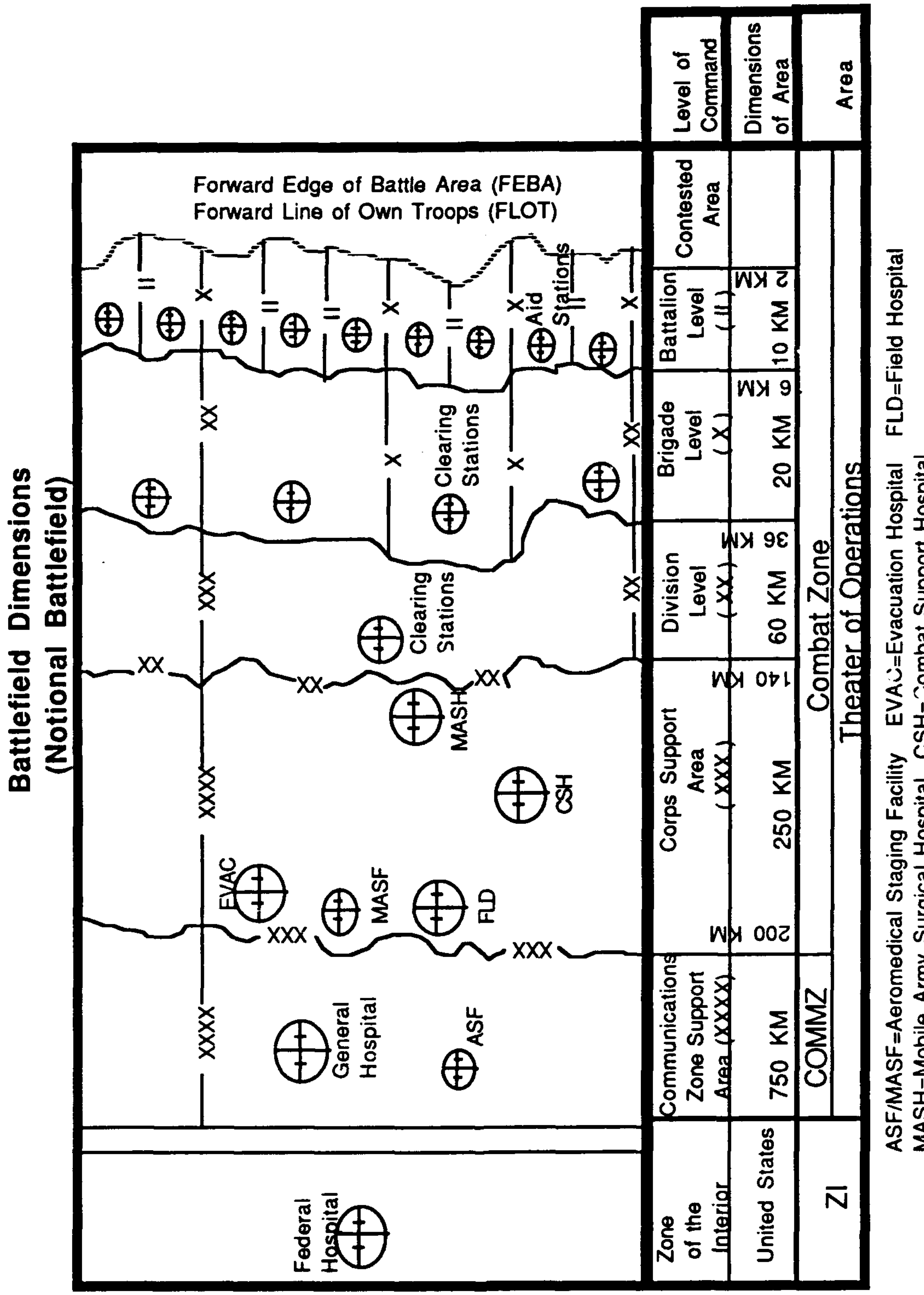

Figure 2. Battlefield Dimensions

These various levels are tied together by an evacuation system using surface and air modes. "The specific mode of evacuation is determined by availability, the tactical situation, climatic conditions," and patient diagnosis/prognosis (FM 8-10, 1978: 4-3). Intermediate levels of care can be bypassed by the evacuation system as deemed necessary for a patient's care (FM 8-10, 1978: 2-5). All three hospitals also evacuate directly out of the Corps area. Figure 3 depicts the relationship between the various levels of medical care and the linking evacuation system.

Current AirLand Battle doctrine divides the flow from division level into two streams Return-to-Duty (RTD) and Non-Return-to-Duty (NRTD). Return-to-Duty casualties are directed to the CSH and the NRTD are directed to the EVAC. Theater and corps evacuation policies determine the categories for RTD versus NTRD. The MASH is to be deleted according to some sources (CGSC-P040, 1988-9:89- 90).

Mobility for field units is measured in the percentage of their equipment and personnel that can be transported in one lift using only their own vehicles; time is not considered in this measurement. Under the doctrine currently in use, mobility for the Corps level hospital units is specified to be 50 percent for the CSH, 20 percent for the EVAC, and 100 percent for the MASH (CGSC-ST 63-1, 1989:2, 10-11). See Table 1.

Future Doctrine (MEDFORCE 2000)

Under the latest proposed AirLand Battle medical support doctrine (MEDFORCE 2000) the CSH and MASH will be retained and the EVAC eliminated in preference to smaller units. The CSH will receive all categories of casualties. MASHes will operate further forward, including in the division rear area, to

provide resuscitation and stabilization to casualties that might not survive the additional travel time to a CSH (AHS Paper, 1989:3-2, 3-3). RTD patients would not normally be treated at a MASH but would go to the CSH or other Corps level medical units. The number of hospitals in a corps area is based on many factors among these are evacuation policy, manpower ceilings, combat tempo, and numbers of patients/casualties. For planning purposes the following allocations of hospitals are proposed: MASH, 2 per corps; CSH, 2.to 4 per division (AHS Paper, 1988:C-2,4). Except for the EVAC, Figure 3 applies to MEDFORCE 2000 doctrine.

MEDFORCE 2000 doctrine recognizes that medical units require the same mobility as the unit being supported and implies that vehicle assets of various medical units might be pooled to support the battle (AHS Paper, 1989:1-8). MEDFORCE 2000 currently designates the MASH to be 100 percent mobile and the CSH to be 35 percent mobile (measured as percentage single lift capability)(AHS Paper, 1989: C-2,4). European/NATO scenarios for battle expect the MASH to require 3-7 days to complete a displacement (teardown, move, reopen) and the CSH to require 17 days to complete a displacement (Dembeck, 1989). Doctrinal mobility and bed requirements are summarized in Table 1. The MEDFORCE 2000 factors and transportation capabilities are evaluated in this study.

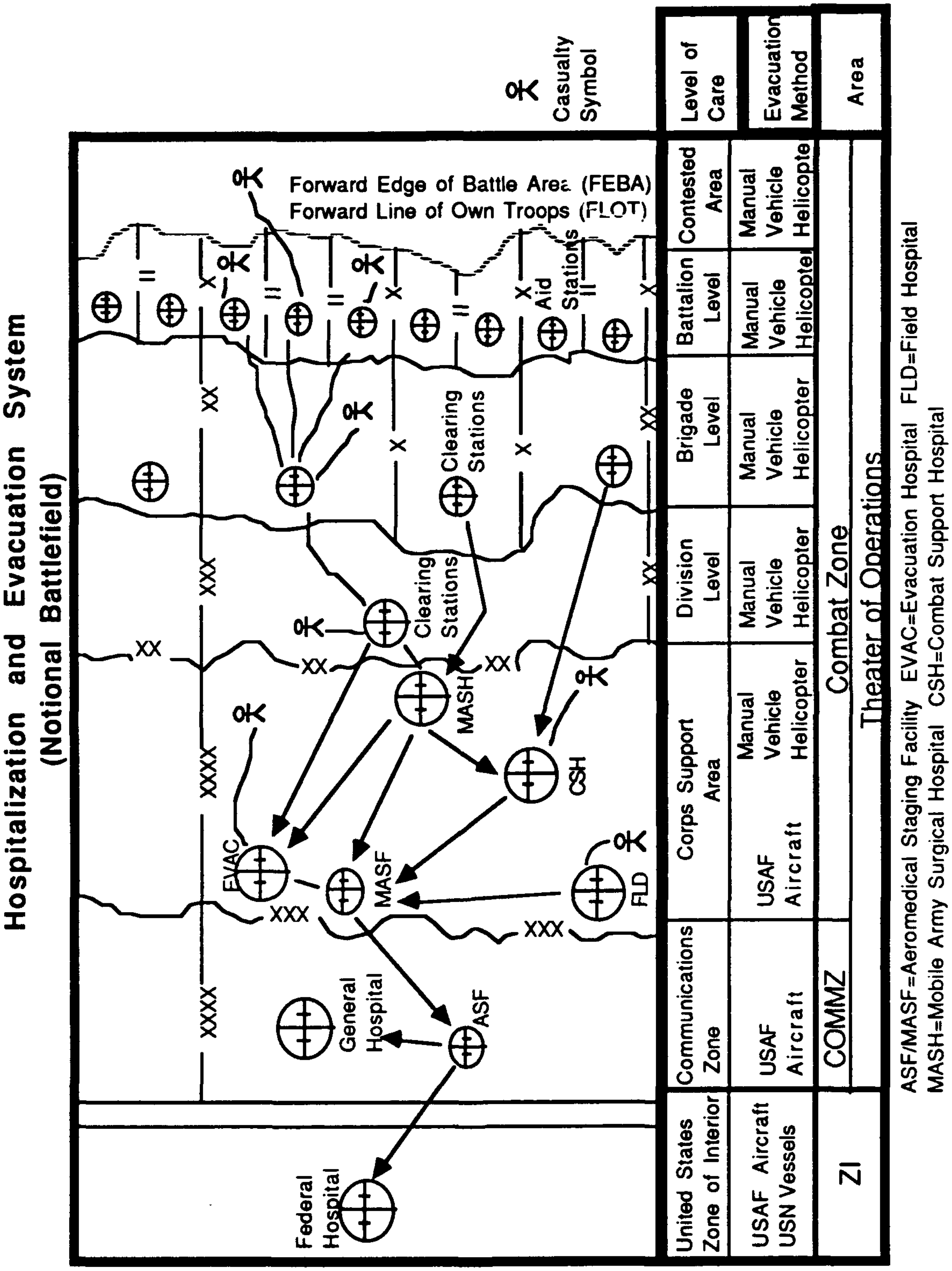

Figure 3. Hospitalization and Evacuation System

Table 1. Mobility and Bed Requirements

Comparison of Mobility and Bed Requirements

Unit	Requirements in Source Documents			
	Current Doctrine		MEDFORCE 2000	
Combat Support Hospital	50%	200	35%	296
Mobile Army Surgical Hospital	100%	60	100%	30
Evacuation Hospital	20%	400	Deleted	N/A
Field Hospital	<10%	400	20%	516
	Note	1	Note	2
	Mobility	Beds	Mobility	Beds

Note 1 Combat Support Hospital TOE - 08123H
Mobile Army Surgical Hospital TOE - 08063H
Evacuation Hospital TOE - 08581H
Field Hospital TOE - 08510H (source CGSC-ST 63-1, 1989:2-10,11)

Note 2 Combat Support Hospital TOE - 08705L
Mobile Army Surgical Hospital TOE - 08763L
Evacuation Hospital TOE - deleted
Field Hospital TOE - 08705L (source AHS Paper, 1989:C-2 to 6, D-1)

Besides the requirement to move units, organic vehicles are required to pickup supplies at various supply points. Estimates for Class VIII Supplies (medical) show an increase in requirements similar to the increases in civilian medical requirements. Previously the estimate was 0.35 pounds per day per man. Now the estimate is about 1.55 pounds per day (AHS Paper, 1989:10-1).

These amounts are not based on the patient strength in the hospital but rather on the total troop strength in the supported area.

It is conceivable that a unit would simultaneously have to allocate vehicles to both move unit assets and perform sustainment operations. Initiatives are being studied by the Department of Defense to reduce supply requirements by providing equipment to units to manufacture medical gases and intravenous (IV) fluids on site. Nuclear or Chemical Warfare (NBC) would drastically increase the estimated medical supply requirements particularly for medical gases and IV fluids plus protective and decontamination materials..

Hospital structures under MEDFORCE 2000 doctrine will be composed of modules. The MASH units will be built from the Hospital Unit Surgical-Main and the Hospital Unit Surgical-Forward. Separate module structures and the melding of these into the MASH are depicted in Appendix D. The CSH will be built from the Hospital Unit Base (HUB) and the Hospital Unit Surgical (HUS). Separate module structures and the melding of these into the CSH are depicted in Appendix E. Field Hospitals will be built from the HUB and the Hospital Unit Holding (HUH) Separate module structures and the melding of these into the FLD are depicted in Appendix F (AHS Paper, 1989:3-2).

Rear Battle Doctrine and Comments

A major component of the AirLand Battle Doctrine is the Rear Battle concept. "Rear battle operations consist of those actions, including area damage control, taken by all units (combat, combat support, combat service support, and host nation) singly or in a combined effort, to secure the force, neutralize or defeat enemy operations in the rear area," (FM 90-14,1985:i). Simply put, the support troops must be able to perform their primary support missions

(including medical) and defend against enemy operations in the rear support areas, including the CSA. Soviet block doctrine emphasizes the use of deep penetration forces and fires to disrupt the support effort (FM 90-14, 1985:1-2). The probability of disruptions in the support areas impacts on transportation requirements reducing the efficiency of transport by necessitating circuitous routing, reduced speeds, requirements for organized convoys, reduced loads on trucks to accommodate personnel for convoy security and allow for rapid personnel dismounts, cross-levelled loads , and other factors. During an echeloned move (several lifts) unit personnel would be required to provide security at old and new locations, and during movement, this reduces manpower available to load, unload, and setup (FM 8-10,1978:3-6). Due to the primarily training environment experience of units, the requirement for security barrier materiels (sandbags, barbed wire and posts) is probably understated in plans further understating transport requirements.

The basis for rear area defense are units grouped to form a Base which has a defined and continuous perimeter (Figure 4). Bases are grouped into a mutually supporting geographically close Base Cluster (Figure 5)(FM 90-14, 1985:4-2,3). In general, no combat troops are assigned to base defense; the support units are responsible for their own defense efforts. Sizes (area covered) of bases and base clusters, air and ground vehicle traffic, and radio traffic makes concealment of support bases nearly impossible. Both the bases and the transport nets are lucrative targets for long-range fires, ambushes, and harassment (Sayen, 1988:33). While movement is often the best way to foil targeting accuracy, support units are burdened with large quantities of supplies and equipment, limited transport resources, and the requirement to maintain support missions (Sayen, 1988:33). Soviet forces and their clients utilize long

range fire support assets with ranges of 35 kilometers for artillery, and 40 to 900 kilometers for surface-to-surface missiles capable of interfering with support unit missions (Sayen, 1988:34).

Hospitals and other medical units will be incorporated into the base defense systems. While the Geneva Convention provides protection to marked medical units from deliberate attack, hospitals might not be marked, in conformity to the tactical commander's requirements, leading to mistaken or misdirected attacks. Hospitals will be responsible for internal security of their areas and possibly their portion of the base perimeter (FM 90-14, 1985:3-18). This will require barrier and construction materials such as concertina wire, sand bags, lumber, and man-hours (Sayen, 1988:38). Medical units at the Corps level are usually deficient in the communications equipment required for perimeter security (particularly telephones) and heavy weapons.

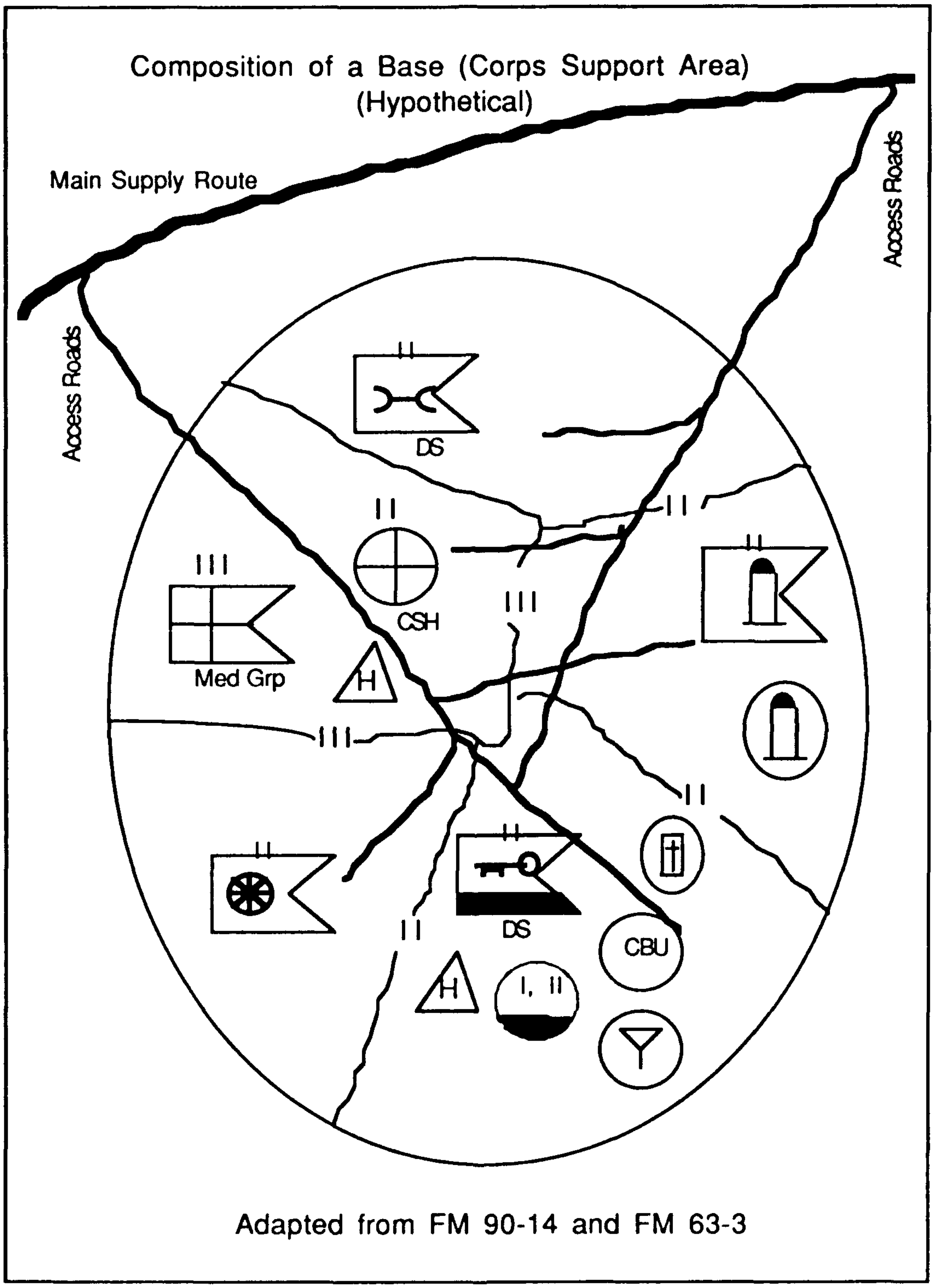

Figure 4. Composition of a Base (Corps Support Area)

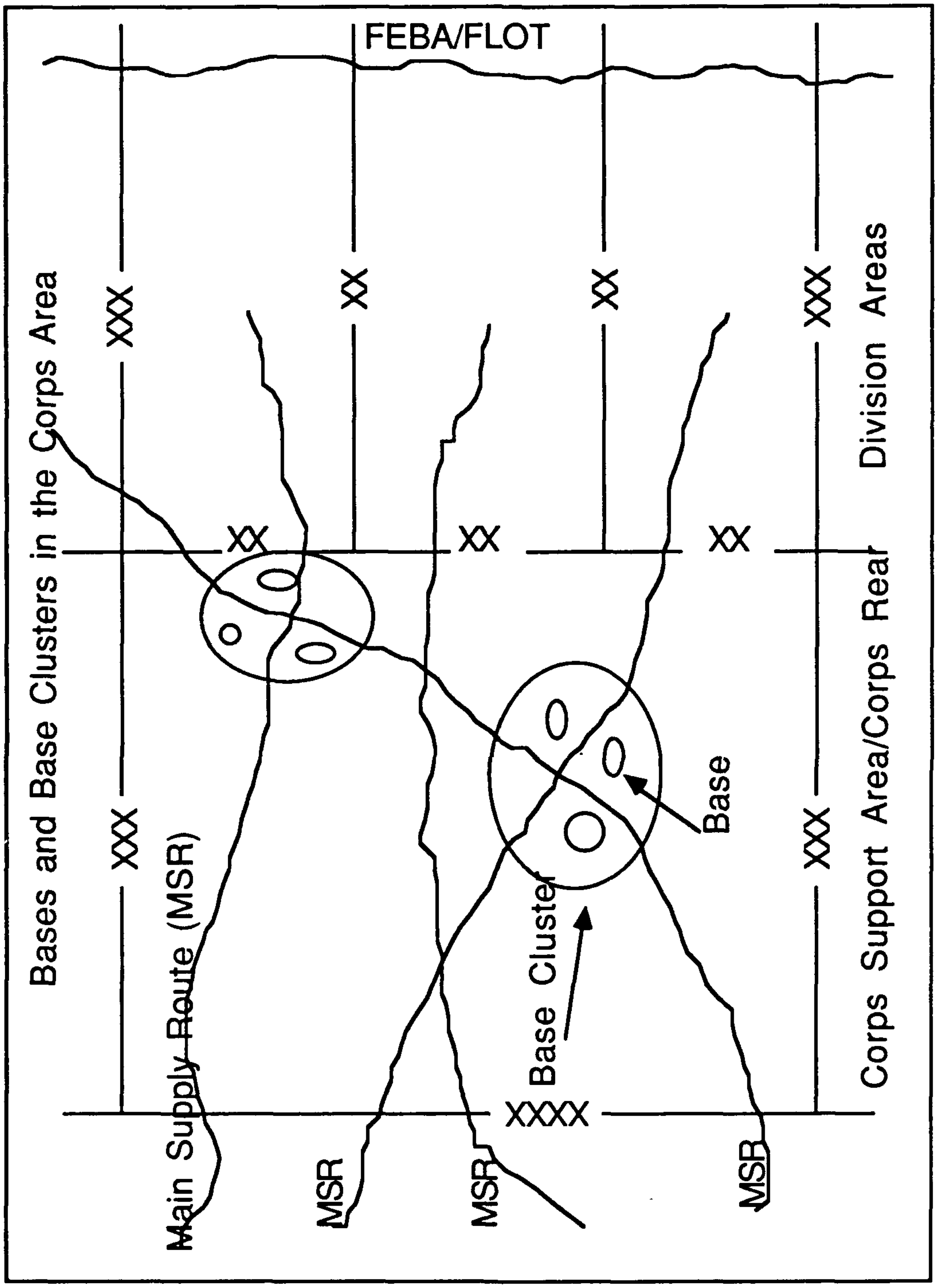

Figure 5. Bases and Base Clusters in the Corps Area

Test and Evaluation Reports on Combat Zone Hospitals

Two evaluation reports were found that describe tests and findings on combat zone hospitals. The reports are not on the same hospital types and much of the equipment is different but some aspects and information are independent of these differences.

Combat Support Hospital (CSH) Evaluation. The first report evaluated a CSH under the MUST equipment concept in 1977. The CSH tested is smaller and lighter than the EVAC in the second test. One interesting aspect of this report is that many of the recommendations for improvements to the unit structure were still lacking seven years later when this author served in a similar MUST unit. One of the test personnel also expressed his disappointment in the unit's equipment and authorizations (ATCD-8, C-7 to C-10). Problems were discovered setting up, disassembling, and moving the 600 cubic foot refrigerator box (LIN R63352). It required too much manpower to erect or tear down and repeated movements rendered it unusable. A disassembled box exceeds the capacity of one truck. The associated refrigeration unit was also difficult to keep in service (ATCD-8, C-5 to C-6). This box and a smaller 150 cubic foot refrigerator (LIN R62393) are often found in the MASH, CSH, and EVAC. The test evaluated the ability of the hospital to perform several relocations in a simulated tactical environment. Movements were designed to simulate a series of 40 kilometer (24 miles) displacements.

Displacement was performed in three echelons and an advance party. An advance party is responsible for scouting the movement route and correcting any obstacles on the route, securing the new site, preparing and marking the new site, establishing communications, and establishing support and defense arrangements at the site. The advance party guides the follow-on echelons into

the site and may act as guides on the march route. In addition, the advance party may need to coordinate and supervise the engineer preparation of the site to render it suitable for use (flat, drainable, water supply, and sanitation [sewage and trash]). The first echelon consisted of a surgical element consisting of two operating rooms (50% of ORs), 40 beds (20% of beds), and other supporting facilities. The second echelon completed the surgical department and added more beds. The third element completed the hospital movement. Vehicle maximum speeds were restricted to 50 KPH (30 MPH) in daylight and 15 KPH (10 MPH) during darkness (ATCD-8, 1977:1-2 to 1-7). While convoys may move under blackout conditions the packing or establishment of hospital shelters can not proceed during blackout (the interiors can be furnished but the exteriors can not be effectively set up) (ATCD-8, 1977:2-20). The test indicated that over the period of the test there was a learning experience and establishment times on subsequent moves improved. The first move took about 44 hours and the fourth move took about 16 hours (ATCD-8, 1977:1-11). The test results were probably slanted to understate the time results due to several constraints on the test; the unit was not at full strength (fewer people to transport, house, and feed), no enemy activity was simulated, patients were discharged/evacuated quickly, the test site was not alien ground, and engineer site preparation was understated (ATCD-8, 1977:1-21). In addition, the units received a movement warning order 24 hours prior to the movement order which should be added to the displacement times, Sufficient daylight (12 hours) was allowed for take down and setup of tents and shelters (ATCD-8, 1977:2-23). Increased travel distances would have a serious effect on the disestablishment to establishment times as this would reduce the amount of critical daylight hours. Issuing the movement order at other than early morning, would have reduced the available daylight hours.

Average march speeds were about 24-30 KPH (14-18 MPH) plus rest periods and other delays (ATCD-8, 1977:2-25,26).

Evacuation Hospital Evaluation. The second test was conducted on a hospital equipped with DEPMEDS in 1988 at Fort Hunter Liggett, California. Several deficiencies were highlighted in the report; the mobilizer (dolly set) for the 20 foot long MILVAN/DEPMEDS shelters broke easily and only worked on improved or firm surfaces, lack of tie-downs in shelters permitted damage to equipment during movement, and lack of storage systems wasted time (ATTE-3, 1988:2-5 to 2-9). The mobilizer has a gross capacity limit of 15000 pounds, this limits the load capacity of the shelters and the firm surface requirement would restrict normal use of the unit. Dolly sets and assigned trucks were found to be capable of moving the unit within 72 hours from one location to another with each lift containing about 20 percent of the total unit (ATTE-3, 1988:2-1,2). It took 56.5 hours for the first section to move 15 kilometers (9 miles) and reestablish operation (ATTE-3, 1988:2-3). Of this time 48 hours were required at the new site to properly align and connect the modules (tents and shelters) and establish utilities (ATTE-3, 1988:2-65). The heatpumps (ECU) required 5 hours to reestablish (coolant purge and recharge time)(ATTE-3, 1988:2-66). Only one movement was tested so it is not known if there would have been a learning experience improvement as found in the CSH test.

Site preparation was required prior to establishment of the new hospital site. Hospital field sites require leveling for the shelters and TEMPER tents, access roads and internal routes, sewage and waste systems, drainage, and water distribution systems. Site preparation during the test (only the leveling, access roads, and partial drainage systems) required about 3.5 to 6.5 engineer machine

hours (ATTE-3, 1988:2-58). Additional site improvements would be required prior to full operational status/patient loads.

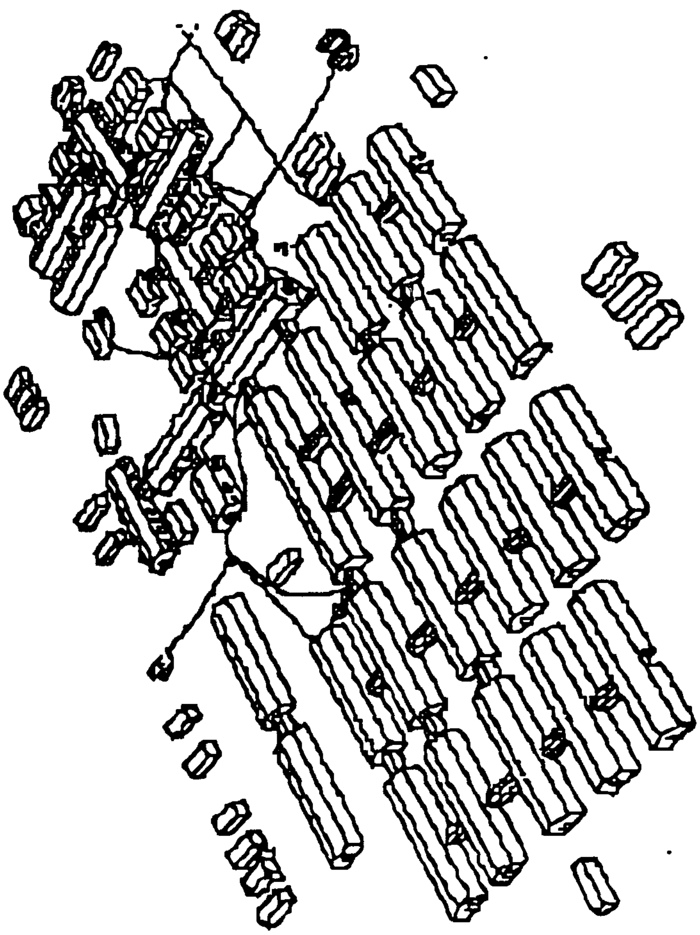

Figure 6. Depiction of a DEPMEDS Hospital

Convoys, Vehicles, and Capacities

Standard US Army cargo vehicles found in the hospital units are classified as medium or light. The primary sizes found are the 1.25 Ton Pickup, the 2.5 Ton Truck, and 5 Ton Truck. Maximum troop carrying capacity is 16 for 2.5 Ton Trucks and 18 for 5 Ton Trucks. This number might be further reduced by the requirement to carry troops' personal equipment (FM 55-30, 1980:10-8). Requirements for passengers to provide security (air watch/guards, route security) may further reduce passenger capacity. Table 2 summarizes the cargo capacities of various trucks, trailers, and containers found in medical units (DEPMEDS ISO Shelters are similar to MILVANs).

Convoys are the normal means of moving unit vehicles and equipment from encampment to encampment. Convoys provide control over unit vehicles, increase collective security, and allow better control over traffic routing. Night blackout convoy speeds average 5-10 MPH. Daytime convoy speeds vary from 15 to 45 MPH depending on road conditions, security requirements, and other factors (FM 55-30, 1980:5-18). These speeds seem relatively slow but faster speeds, particularly over rough roads, lead to the accordion effect when vehicles can't maintain a steady speed. Additionally, heavily loaded trucks or those with heavy or long trailers often have difficulty negotiating hills and sharp turns requiring slow speeds.

Table 2. Cargo Truck & Trailer Capacities

Cargo Truck & Trailer Capacities

Vehicle Type	Capacity (pounds)	Towing (pounds)	Cargo Bed Dimensions (ft)			
			Length	Width	Height	Cubic Ft
1.25 Ton Truck	2500	1500	8.2	5.8	4	160
.75 Ton Trailer	1500	N/A	7.9	5.4	2.8	114.6
2.5 Ton Truck	5000	2000	11.5	7.3	4.2	351.4
1.5 Ton Trailer	3000	N/A	9	6	3.7	205
5 Ton Truck	10000	30000	14	7	4.2	550
7.5 Ton Dolly	15000	N/A	N/A	N/A	N/A	N/A
MILVAN	41300	N/A	20	8	8	1027.1
CONEX-I	9000	N/A	4	6	6	136.1
CONEX-II	9000	N/A	8	6	6	286.96

Extracted from FM 55-30 pages 1-7 & 1-12, FM 55-65 pages A-9,11, & FM 55-15 pages 3-82&84

Convoys (march columns) usually are divided into serials of about 20 vehicles. The convoy consists of three parts: a head, main body, and trail. The main body might be subdivided into serials and the serials subdivided into march units. The head controls the pace of the convoy and keeps the unit on route and on schedule. The trail is responsible for controlling stragglers and performing maintenance to return stragglers to the convoy. On occasion a fourth element may be used as a path finder to clear or mark a route (particularly at night) (FM 55-30, 1980:5-2). Control over the convoy is exercised by the convoy commander and commanders of the various march elements. The radio net and procedures need to be established prior to departure and include; convoy commander, trail commander, escort or security force commander, march element commanders, and recovery and maintenance vehicles (FM 55-30, 1980:5-3). Medical units at the Corps level are normally deficient in sufficient radios to control a convoy.and operate two sites.

Developments in Equipment 1980-2000

The WWII and Korea combat hospitals were tent designs and relatively transportable by truck (2-4 men can load a large tent on a truck). The Vietnam War introduced the air conditioned MUST hospital. MUST hospitals are packaged in 30 or more multipurpose expandable hardwall shelters (about 12 feet long by 8 feet high by 7 feet wide) weighing up to 10000 pounds when packed. The medical treatment areas of MUST units operated in an interconnected system of hardwall shelters and inflatable quonset huts.

To modernize the 1960s MUST equipment and create tri-service standardization, the new 1980s Deployable Medical System (DEPMEDS) is replacing the existing MUST equipment. DEPMEDS hospitals consist of

interconnected tents and probably 30 or more DEPMEDS hardwall shelters and MILVANs (ISO or Sealand boxes about 20 feet long by 8 feet high by 8 feet wide) weighing up to 20000 pounds when packed. The MUST unit was difficult to truck over unimproved roads and it should be expected that the heavier and longer DEPMEDS units will be even more difficult to move with the flow of battle. DEPMEDS units require great precision in layout, and increased site preparation, due to the greater rigidity of the tent frames compared to the inflatable shelters in MUST hospitals. A visited DEPMEDS units indicated that it could only establish a static display without extensive support from truck companies and heavy container movers. The dollies were almost unusable in all but idea conditions (a paved parking lot). Additionally, an operational unit would be flooded out by sewage unless an extensive piped waste system was installed prior to set up.

Conclusion

Historically the type of warfare, force structure, technology, and medical care expectations have driven the shape of combat medical support. The simultaneous advent of mechanized warfare and increasingly sophisticated medical care have placed two forces in conflict. On one side is the necessity to remain mobile to conform to the requirements of the battlefield. On the other side is the desire to provide the best and most modern medical care to the combat zone, even though the achievement of a high level of care creates a heavy possibly immobile hospital. The history of US Army combat medical care in the last 30 years indicates a trend away from mobility despite the supported combat arms becoming more mobile. Further study needs to be conducted to determine if the medical unit immobility trend has been arrested and corrected toward conformity to the requirements of the mobile battlefield.

IV. Methodology for Conduct of Research

Overview

This chapter describes the research data collection techniques used to answer the investigative questions introduced in Chapter I. These questions are based on the research objective of studying and quantifying the Corps Area hospitals' organizational structures and associated personnel and equipment to determine unit transportation requirements and capabilities. Relational database progra: s were developed as part of the research process to manage and correlate much of the quantitative data gathered to answer the research questions listed below. DBASEIII+ was used as the basic software as it is the most common database program available to units and many other database programs have the ability to import DBASEIII+ data files. The MSDOS version of the program was used because generic MSDOS desktop computers are the most common type available to military users. Debugging and verifying gathered data was performed by manually verifying database entries compared to source documents. Information from the databases was sampled (about 5%) and computed manually for comparison to the automated reports from DBASEIII+.

The the two most significant problems encountered in the research process were:

1. Identifying and quantifying the discretionary equipment items.
2. The moving target nature of the basic organization authorization documents, the Tables of Organization and Equipment (TOE), as these were under revision due to the initial fielding nature of major equipment items and new doctrine.

The basic nature of the study is not different from the calculations performed during the TOE design process to determine unit equipment weight,

displacement, and required transportation assets. This study attempts to more fully identify total requirements by better identification of discretionary equipment. Appendix A of FM 55-65, Common Tables of Allowances (CTA), and the author's experience are the primary guides.

Medical units under the DEPMEDS concept are composed of two subunits each containing subsections or paragraphs corresponding to work sections/departments. These two subunits have been amalgamated by the author into a single structure for each hospital type. The structure of the individual subunits (by paragraph) and the resulting amalgamated unit (the central column) are depicted in the Appendices.

Research Techniques

Question One

Question. *What equipment and personnel* are included in the Table of Organization and Equipment (TOE) and associated authorization documents for the Corps hospitals?

Technique. The organizational structure for a US Army tactical unit is specified by a document called the Table of Organization and Equipment (TOE). Each unit is established based on an applicable TOE which includes all authorizations for manpower and major items of equipment. The equipment authorizations are supplemented by discretionary items required for mission accomplishment, efficiency, or comfort and authorized by Common Tables of Allowances (CTA). The authorized equipment quantities extracted from these documents are used in conjunction with other data in a relational data base to quantify cargo and personnel movement requirements and capabilities. Both TOEs and CTAs are US Army documents.

Question Two

Question. What are the weights, sizes, and special characteristics of hospital equipment requiring transport?

Technique. The official weights, dimensions, and special characteristics of the equipment items discovered in Question One are found in the Unit Assembly (UA) Listings for medical assemblages and in the Packaging File for other items. The UA is provided by the US Army Medical Material Agency and the Packaging File is provided by the US Army Catalog Data Agency. Another document used, as needed, to cross-reference between TOE, CTA, UA, and Packaging File is Supply Bulletin 700-20. The derived weights and dimensions are included in the relational data base for use with other collected data to determine transportation requirements (quantity authorized * weight = total item weight, quantity authorized * dimensions = total item size). Generally, only the official weights and dimensions were used. To gather this data by direct measurement would be expensive, time consuming, and difficult to coordinate for research at this level. In general, the official weights and dimensions will err to the large or heavy side as these are the factory pack measurements. Weight and dimension data are detailed in the Appendices for each of the three units..

Question Three

Question. Does the authorized transportation equipment have the capacity to accommodate the units' equipment and personnel and achieve the doctrinal mission mobility requirement?

Technique. Vehicle and trailer capacities are determined from Field Manuals (FM) 55-15 and 55-30 combined with the vehicle and trailer quantities derived in Question One to determine the total unit transport (lift)

capacity or capability (quantity authorized * capacity = total unit vehicle capacity). Lift capacity is measured in three ways: cubic feet capacity, weight capacity, and towing capacity. This total gross lift capability (vehicles) is compared to the total gross lift requirement (personnel and equipment) to determine the percentage of lift capability or factor (capability / requirement * 100).

Two additional transport capacity versus requirement factors can be computed. First, a factor can be determined by removing required seating space from the cargo capacity and computing the factor (remaining capacity / cargo requirement). Second, a factor can be determined by removing nonreusable cargo space (MILVANs and Expandables-with their cargo) from the total capacity and computing the factor (remaining capacity / remaining cargo requirement).

The doctrinal single lift requirement was determined from US Army doctrine reviewed in Chapter III.

Comparison of the doctrinal requirement and the lowest computed capability percentage will determine if the unit structure meets or fails to meet the doctrinal requirement.

Summary of Research Methodology

The information discovered in Chapters III and using the techniques described in this chapter are analyzed in Chapters V and VII to answer the Problem Statement - Do Corps Area hospitals have sufficient organic transport capability to conform to doctrinal requirements for self-movement? In addition, the discovered and analyzed data is used to develop a computer assisted decision aide for commanders and hospital staff to determine the affect on

transportation requirements caused by various mission and environmental variables for the three studied hospitals. Appendices display the unit structures (D, E, and F), composition, and item weight and cubic measurements (A, B, and C).

Due to the size and and nature of the information in several of the appendices, data and programs are not provided in printed form. Rather, the appendices are stored in electromagnetic format on computer disks. Copies of the disks are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

V. Gross Requirements, Capabilities, and Findings

Introduction.

Chapter V provides, in a concise manner, summary of the data developed in the thesis. The weight and dimension data for each of the three hospitals is summarized and compared to the doctrinal mobility requirement. The numerical data is analyzed first in a gross manner assuming perfect utilization of cargo capacity. Secondly the data is examined taking into account the inefficiency of loading personnel, but still assumes efficient loading of cargo.

Mobility or mobility factor is expressed as a percentage. The percentage is derived by dividing the total lift capacity (unit owned transportation assets) by the total requirement to be moved (the sum of unit personnel and equipment). US Army doctrine details the required mobility capability or factor that unit structure (TO&E) designers are to achieve.

Weight and dimension information can be developed for unit personnel and equipment. However, there are inefficiencies in using vehicle space and weight capacity because cargo and personnel can not be packed to make full use of the capacity. Among the reasons for inefficiency are odd shapes (cargo and people), safety conflicts (ammunition segregation, fuel and oxidizer separation, people and cargo, etc.), security, unit integrity requirements, and cross-loading requirements. Only three computation methods are considered in this study. First, full efficiency is computed (best case). Second, personnel inefficiency with full cargo efficiency is computed.
Consideration of all inefficiencies is beyond the time available to this researcher to compute. Third, the number of available tow hooks versus the number of trailers and dollies requiring towing is considered. Tow hooks are

not perfectly substitutable. Only the 5 Ton Truck (15000 LB tow capacity) can tow the 100 Kilowatt Generator (7160 LB) or the 7.5 Ton Dolly with load (15000 LB). The 2.5 Ton Truck (6000 LB tow capacity) can tow generic 1.5 Ton Trailers (5800 LB). The 1.25 Ton Truck (3000 LB tow capacity) can tow generic 3/4 Ton Trailers (2800 LB) (FM 55-15, 1986:3-70 to 3-79).

Computations of mobility are made for each of the three considerations. The lowest mobility factor is used as the achievable mobility for the unit. This is intuitively obvious. In the vernacular, if you cube-out before you weight-out the remaining weight capacity is unusable and if you weight-out before you cube-out the remaining cubic capacity is unusable.

Mobile Army Surgical Hospital (MASH)

Gross requirements (how much weight and cube), vehicle capacities, and general findings for the MASH are included in this section. Weight and cubic dimension totals are extracted from Appendix A. Capacity measurements are depicted in this section based on the vehicles assigned to the unit and the cargo capacities shown in Table 2 of Chapter 3.

Transportation Capacities. The capacities of the unit's vehicles are displayed in Table 3.

Requirements. The results of summation of the MASH database in Appendix A indicate these totals: 212520 pounds.

18835 cubic feet.

TABLE 3

Unit Vehicles and Capacities

Vehicle	Quantity	Capacities		Extended Capacities	
Truck, 1.25 Ton	3	2500 lbs	160 cf	7500 lbs	480 cf
Trailer, .75 Ton	3	1500 lbs	115 cf	4500 lbs	345 cf
Truck, 2.5 Ton	9	5000 lbs	351 cf	45000 lbs	3159 cf
Trailer, 1.5 Ton	9	3000 lbs	205 cf	27000 lbs	1845 cf
Truck, 5 Ton	8	10000 lbs	550 cf	80000 lbs	4400 cf
Pounds=lbs		Total Capacity Lbs		164000 lbs	
Cubic Feet=cf		Total Capacity CF		10229 cf	

MASH Results. Comparing the total cargo and personnel requirements with the total cargo and personnel capacity shows the MASH is not 100 percent mobile in organic transportation. Using the pounds figures, a mobility of 77 percent is calculated. Calculations with the cubic feet figures result in a mobility of 54 percent. The unit therefore has an effective mobility of only 54 percent. Given the data available and assuming perfect space utilization the unit with its current vehicles falls short of the doctrinal requirement of 100 percent capability.

When the inefficiencies of personnel seating are factored in calculations of lift capability the percentage drops lower. If seating for 132 persons is factored out of the available cargo capability (taking into account seats in cabs) the unit is not able to meet the doctrinal lift requirement (this still assumes perfect utilization by cargo). After factoring out the seating only 6840 cubic feet and 112800 pounds of capability are available. This capacity computes to about 57 percent of lift for total weight and 43 percent of lift for total cubic feet.

The figures would drop lower if various inefficiencies of cargo packing are factored into the calculations (safety, odd sizes, section integrity, etc.).

Combat Support Hospital (CSH)

Gross requirements (how much weight and cube), vehicle capacities, and general findings for the CSH are included in this section. Weight and cubic dimension totals are extracted from the Appendix B. Capacity measurements are depicted in this section based on the vehicles assigned to the unit and the cargo capacities shown in Table 2 of Chapter 3.

Transportation Capacities. The capacities of the unit's vehicles are displayed in Table 4.

Requirements. The results of summation of the CSH database in the Appendix B indicate these totals: 1015759 pounds.

91085 cubic feet.

TABLE 4

Unit Vehicles and Capacities

Vehicle	Quantity	Capacities		Extended Capacities	
Truck, 1.25 Ton	2	2500 lbs	160 cf	5000 lbs	320 cf
Trailer, .75 Ton	1	1500 lbs	115 cf	1500 lbs	1500 cf
Truck, 2.5 Ton	1	5000 lbs	351 cf	5000 lbs	351 cf
Trailer, 1.5 Ton	6	3000 lbs	205 cf	18000 lbs	1230 cf
Truck, 5 Ton	25	10000 lbs	550 cf	250000 lbs	13750 cf
MILVANs	24	11500 lbs	1027 cf	276000 lbs	24648 cf
Expandables	14	9500 lbs	946 cf	133000 lbs	13244 cf
Dolly, 7.5 Ton	37				
		Total Capacity Lbs		688500 lbs	
		Total Capacity CF		55043 cf	

Pounds=lbs
Cubic Feet=cf
Expandable is based on 1:2 Shelter (1:3 Shelter has less capacity)

CSH Results. Comparing the total cargo and personnel requirements with the total cargo and personnel capacity shows the CSH exceeds the required 35 percent mobility in organic transportation. Using the pounds figures, a mobility of 68 percent is calculated. Calculations with the cubic feet figures result in a mobility of 60 percent. Considering towed loads there are nine 100 Kilowatt generators and two water trailers besides the towed loads shown in Table 4. Only the five ton trucks can tow the dolly or generator safely which limits flexibility of prime movers. Considering the potential large towed loads, there are 56 potential requirements compared to 26 capable vehicles for a capability of 46 percent. Because of the towed load limitation the unit has a gross effective mobility of 46 percent. Utilizing the data that was available for study, the CSH exceeds the doctrinal requirement of 35 percent assuming perfect space utilization.

When the inefficiencies of personnel seating are factored in calculations of lift capability the percentage drops. If seating for 35 percent of the personnel (210 persons) is factored out of the available cargo capability (taking into account seats in cabs) the unit is not able to meet the doctrinal lift requirement (this still assumes perfect utilization by cargo). After factoring out the seating only 21352 cubic feet and 277200 pounds of capability are available (31760 cubic feet and 354571 ponds required at 35 percent). This capacity computes to about 27 percent of lift for total weight and 24 percent of lift for total cubic feet. The figures would drop lower if various inefficiencies of cargo packing are factored into the calculations (safety, odd sizes, section integrity, etc.).

Field Hospital (FLD)

Gross requirements (how much weight and cube), vehicle capacities, and general findings for the FLD are included in this section. Weight and cubic dimension totals are extracted from Appendix C. Capacity measurements are depicted in this section based on the vehicles assigned to the unit and the cargo capacities shown in Table 2 of Chapter 3.

Transportation Capacities. The capacities of the unit's vehicles are displayed in Table 5.

Requirements. The results of summation of the FLD database in the Appendix C indicate these totals: 843327 pounds.

71402 cubic feet.

TABLE 5

Unit Vehicles and Capacities

Vehicle	Quantity	Capacities		Extended Capacities	
Truck, 1.25 Ton	3	2500 lbs	160 cf	7500 lbs	480 cf
Trailer, .75 Ton	2	1500 lbs	115 cf	3000 lbs	230 cf
Truck, 2.5 Ton	0	5000 lbs	351 cf	0 lbs	0 cf
Trailer, 1.5 Ton	1	3000 lbs	205 cf	3000 lbs	205 cf
Truck, 5 Ton	17	10000 lbs	550 cf	170000 lbs	9350 cf
MILVANs	19	11500 lbs	1027 cf	218500 lbs	19513 cf
Expandables	9	9500 lbs	946 cf	85500 lbs	8514 cf
Dolly, 7.5 Ton	28				
		Total Capacity Lbs		487500 lbs	
		Total Capacity CF		38292 cf	

Pounds=lbs
Cubic Feet=cf
Expandable is based on 1:2 Shelter (1:3 Shelter has less capacity)

FLD Results. Comparing the total cargo and personnel requirements with the total cargo and personnel capacity shows the FLD exceeds the required 20 percent mobility in organic transportation. Using the pounds figures, a mobility of 58 percent is calculated. Calculations with the cubic feet figures result in a mobility of 54 percent. Considering towed loads there are nine 100KW generators and two water trailers besides the towed loads shown above. Since only the five ton trucks can tow the dolly or generator safely, this limits use of prime movers. Considering the potential large towed loads, there are 39 potential requirements compared to 17 capable vehicles for a capability of 44 percent. The unit's mobility is limited to 44 percent by the prime movers versus towed load factor. Considering the data that was available for study, the FLD

exceeds the doctrinal requirement of 20 percent assuming perfect space utilization.

When the inefficiencies of personnel seating are factored in calculations of lift capability the percentage drops. If seating for 20 percent of the personnel (88 persons) is factored out of the available cargo capability (taking into account seats in cabs) the unit is still able to meet the doctrinal lift requirement (this still assumes perfect utilization by cargo). After factoring out the seating, 14670 cubic feet and 275900 pounds of capability are available (11634 cubic feet and 152789 pounds required at 35 percent). This capacity computes to about 36 percent of lift for total weight and 25 percent of lift for total cubic feet. The figures would drop lower if various inefficiencies of cargo packing are factored into the calculations (safety, odd sizes, section integrity, etc.).

Conclusion

Two of the three hospitals studied fail to meet the doctrinal requirement for mobility. It must be remembered that the available official data possibly understates the total cargo requirement. The study also assumes better utilization of capacity than is normally possible.

Results, above, for the three hospitals are summarized in Table 6.

TABLE 6

Summary of Results

Unit	Required Capability	Computed Capability
MASH	100%	43%
CSH	35%	24%
FLD	20%	25%

VI. Computer Based Decision Support Assistant

Introduction

A common problem encountered by the staff of mobile medical units and headquarters is the need to estimate transportation requirements to move a unit. If the problem were solved by a one time calculation, that computed answer could be used repeatedly. However, there are many variables that affect the calculations and each solution can be unique. A properly designed Decision Support System (DSS) can minimize the drudgery of manual calculations and speed the collation of large amounts of data into small understandable summaries. This researcher designed a DSS which allows the user to view the affects of changes in variables and gives a rapid satisfactory answer (not an exact answer).

The DSS is a menu and question-response driven program that is easily learned by users of simple computer programs. The questions require the user to provide information necessary for program operation. All information is normally available to the unit commander and staff from daily unit reports, operations orders, and intelligence summaries. Supporting data files (required for program operation) are built and maintained using information contained in unit personnel and property files or reports.

It is expected that the DSS would be used by the commanders and operations staffs at the hospitals and at the higher headquarters of the hospitals. Operation of the program would provide a relatively rapid answer to determine whether outside transportation assets (and how much) would be required to fulfill movement requirements in the allotted time.or number of

lifts. Automation of the calculations will reduce the workload on staffs and ensure greater accuracy particularly in times of stress.

The most common and useful variables (in the author's experience) are: transportation assets, number of personnel, equipment levels (with weight and dimension data), deployment schedule/order, mission, and weather. Available transportation assets can be determined from movement orders, coordination with transportation control centers, and unit maintenance reports. The number of personnel is available from the unit personnel section and/or unit commander. Unit equipment levels are generally available unit's supply section (Property Book and Hand Receipts). Periodic intelligence summaries provide light and weather data which can affect required equipment and time requirements. Movement or Operations Orders from higher headquarters will generally give the time allotted to make a move and what the expected mission will be at the new location. The order helps the hospital commander and staff determine which sections to move and when;.provided existing patient loads can be shifted to other units (possible directed in the order). The mission type is used in the program to determine exclusion of war fighting equipment and heaters (at warm temperatures) from movement requirements for non-combat missions

A computerized decision support system was developed for the three hospitals studied in this thesis. This DSS can be used at the unit and headquarters level to perform what-if analysis of different variables effects on unit movement capabilities and thereby develop relatively fast and accurate projections for ground movement.

The program code for use with DBaseIII+ is listed in Appendices G, H, I, and J. Due to the length of the program code the appendices are in

electromagnetic format on magnetic disks. Copies of the disks are available on request from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

Choice of software to build the program was limited by funds (none), programmer experience, and what is commonly available to the medical units. DBaseIII Plus, by Ashton-Tate, is a capable programmable database file manager that met the requirements.

Variables are provided to the decision support system (DSS) for computation by keyboard and data files. Keyboard entries are prompted by the program to gather variables of: mission, temperature, available vehicles, and movement order. Database files provide information for the variables of: number of personnel by section, unit structure, number of unit vehicles and trailers by section, unit equipment by section, and weight and dimension data.

Program code lists for the four programs are provided in the Appendices. DSS structure and operation is described in the subsequent paragraphs.

Basic Program Structure.

The DSS is comprised of four separate programs. First is a central program that queries the user for the type of unit (MASH, CSH, or FLD). Based on the answer from the user, the central program hands over operation to the appropriate program specific to the type unit. DBaseIII+ must be in operation and the DSS initiated with the command GO DSSMAIN1.at the dot prompt inside DBase. At the end of the operating session the unit program returns operation to the central program which allows the user to exit and shutdown DBaseIII+. All the appropriate data files must be on the same drive as the program and hard disk operation is recommended.

Database Files Structure.

These data files and their associated index files must be maintained/updated for the programs to operate properly. Any moderately experienced user can perform the maintenance from the ASSIST command structure in DBaseIII+. Structures of the database files are as follows:.

1. Personnel Data; Key field (PERSO or PERSE), Nomenclature (Personnel Officer or Enlisted), Quantity (in the section), TOE Number, Paragraph Number, Paragraph Name (duty section), TOE Date, Notes Field.

2. Equipment Data; Key field (LIN-item identification code), Nomenclature (equipment name), Quantity (in the section), TOE Number, Paragraph Number, Paragraph Name (duty section), TOE Date, Notes Field.

3. Transport Data; Key field (LIN-item identification code), Nomenclature (equipment name), Quantity (in the section), TOE Number, Paragraph Number, Paragraph Name (duty section), TOE Date, Notes Field.

4. Transportation Capacity (not used for the MASH); Key field (Vehicle type), Quantity, Capacity-Cubic, Capacity-Weight, Quantity of Cab Seats, Quantity of Bed Seats, Total Cube, Total Weight, Total Cab Seats, Total Bed Seats, and Notes. The DSS program searches the Transport Data file consolidates the information into the Transport Capacity file and computes the information for the Total fields based on the quantities extracted from the Transport Data.File and keyboard entries. Containers are excluded from consideration as multiple lift containers.

5. Weight and Dimension Data; Key field (LIN-item identification code), National Stock Number (NSN), Nomenclature (equipment name), Unit of Issue (UI), Unit of Issue Weight (pounds), Unit of Issue Dimension (cubic feet), Document Number (Technical Manual, etc), Document Date, Notes Field.(short), Notes Field (long), Temperature (when is item required-Fahrenheit), Mission Mode (all

missions or combat only). Medical sets shipped in Expandables or MILVANs use weight and cubic measurement of the set minus the capacity of the container to preclude the consideration of container capacity for multiple lifts.

6. Unit Structure; Key Field (Paragraph Number), Cubic measure of section personnel-total, Number of personnel in section, Cubic measurement of section equipment-total, Weight of section equipment-total, Percent assigned to each lift (5 fields), Divisor for each section (divisibility factor of section). All fields, except the paragraph number and the divisor, store information gathered by the DSS from the personnel, equipment, and item data files.

Keyboard Queries and Program Operation

The program queries the user for various pieces of information to use in performing computations. Queries are listed in their order of occurrence. Only the significant queries are listed and explained below.

What unit is to be considered? The user/operator initiates the program from the DBaseIII+ dot prompt with the command DO DSSMAIN1. The program verifies that the user wants to continue and if so displays a menu screen and requests designation of the unit to be studied. The possible selections are the three units and exit. If the user selects one of the units program control is passed to the appropriate unit program DSS1 (MASH), DSS2 (FLD), or DSS3 (CSH).

What is the unit mission? Once the unit program assumes control it verifies that the operator wishes to continue and, if affirmative (yes), asks for the mission type. The options are Combat/Combat Training or Humanitarian. Algorithms in the program exclude Combat equipment from the weight and dimension totals for Humanitarian missions.

What is the expected low temperature? The operator is queried for the expected low temperature during the mission. Currently, the program excludes those items of equipment from the weight and dimension totals that are only required at temperatures less than the stated temperature. Low temperature equipment is only excluded for Humanitarian missions. The program assumes that combat missions are of unknown duration and all seasonal equipment is required.

What are the available unit vehicles? The program searches the Transportation file and summarizes the unit assets found there in a screen display. Verification of the displayed quantities is asked of the user.

What are the available non-unit vehicles? A screen display asks for the user to provide the quantities of any non-unit vehicles that will be available for the movement. Once the quantities are verified the unit and non-unit vehicles are summed and stored in the Transportation Capacity File.

Display of the vehicle information. The summed vehicle information is displayed for the user based on the two previous queries.

Computation of section personnel, weight and cube totals. Once the vehicle information is confirmed a non-interactive segment of the program performs a consolidation of movement requirements. The program interrogates the Personnel and Equipment Files section by section for numbers and types of equipment or personnel. This is matched in the Equipment Data file to gather weight and dimension information. The computed information is stored in the Unit file by section with the total personnel and equipment weight and dimension totals.

What is the movement schedule for the unit? Once the program has finished summarizing personnel and equipment it queries the user for a

movement schedule. The Unit file is first queried by the program to gather the divisibility factor for each section (Divisor field). A screen is then displayed with a fill-in-the-blank query for the user to establish the movement order and portion for each section. The MASH is allowed a choice of three movements (lifts) and the CSH and FLD are allowed five movements. It is recommended that the user use only the divisor (or multiples) or one (1) when establishing the movement schedule. The schedule for each section must total to one across the several lifts because the program does not allow sections to be abandoned by accident nor can a section move more personnel and equipment than it owns or controls. For example, the Central Material section may have a divisor of 0.5. This means the user can assign all of the section to one lift (enters 1) or may split the section across two lifts (enters 0.5 in two different lift columns). The assigned schedule is stored in the Unit file.

Display of results for each scheduled lift. Based on the previous program actions and user inputs a series of displays are prepared for the user. Each movement is separately displayed with an analysis of whether the total personnel and equipment for the lift can be accommodated by the transportation assets. There are three displays for the MASH and five for the CSH and FLD. The number of personnel and amount of equipment assigned to each lift are proportional to the movement assignments.

Hard copy printout of results for each scheduled lift. The previous screen displays show information for each lift individually. The hard copy report displays all of the information gathered from the user or data files in one consolidated report. This is handier than the earlier report which is only available on the screen. The printout also provides a permanent record for future reference by the planners or commander. Preparation of the report

includes analysis of the available personnel seating compared to the proposed movement schedule. If there are not enough seats in vehicle cabs (including any buses) an appropriate number of cargo trucks are assigned to transport personnel. If too many personnel were assigned to a lift during the scheduling query it would reduce truck cargo capacity and may render the unit immobile. Perfect utilization of remaining cargo space by cargo has been assumed due to limitations in the programming language and programmer's skill. Obviously perfection is not possible so the cargo space requirement is probably understated.

Summary

This Decision Support System is an initial effort to simplify and speed the analytical process used by hospital and medical headquarters commanders and theirs staffs when determining the interaction between requirements and capabilities for hospital moves. As small computers become common in headquarters and field units, programs such as this DSS provide a means of managing large amounts of data in a rapid manner. This capability, hopefully, reduces the chance element and increases the deliberate element in successful operations. In addition, a computer is less affected by stress and fatigue than its human operator and will produce more consistent and valuable answers.

Without this DSS system there are several alternative methods to perform the calculations. First, calculate manually with the attendant slowness and likely mistakes. Manual calculations would tend to make many simplifying assumptions (reducing accuracy) and take many man-hours (estimated to be at least 24-36 man-hours). The developed DSS takes about 15-30 minutes to perform calculations on an IBM XT clone (286 chip or 386 chip based computers are much

faster than the 8086 chip IBM XT). Second, calculate using a computer spreadsheet such as Lotus 123 or Quattro. Spreadsheets calculate faster than DBASEIII+ but random access memory limits can be exceeded on older computers causing program failure (data for FLD and CSH will exceed 640K RAM). Relational databases (DBASEIII+) are more efficient in storing and modifying information compared to spreadsheets. User access to program code and data is also easier to control with database programs compared to spreadsheets (a safety factor). Additionally, the data for a spreadsheet may be too bulky to fit on a single floppy disk, even a high density disk. Therefore, a spreadsheet program would be unusable on IBM XT and IBM AT type computers. Third, an expert could mentally determine requirements in a few minutes. Unfortunately, the only way to develop true experts (not persons who just think they are experts) is during an extended war of mobility and this would take several month or years. Peacetime training budgets, available time, and personnel transfers preclude development of true experts.

VII. Conclusions and Recommendations.

Introduction

This thesis investigated the question, do hospitals in the corps area have sufficient organic (unit owned) transportation resources to conform to the mobility factor (percentage) established in the MEDFORCE 2000 doctrine? This was considered necessary by the researcher due to the past history of these units not conforming to doctrinal requirements and to determine if the new proposed organization authorization documents corrected past shortages.

The findings of the research are condensed in this chapter in two basic groupings. First, conclusions based on the numerical data discovered during research. Second, recommendations to correct shortcomings in hospital transportation assets and organization.

Conclusions

Using official data sources and authorization documents, the MASH and CSH fail to meet the doctrinal mobility requirements and the FLD is only barely above the doctrinal requirement. If the factors of cargo space utilization inefficiencies and cargo safety and security incompatibilities are also considered, the already low mobility would drop further. The computed capability shown in Table 6 should be considered the highest (most optimistic) achievable measure with the data set used in this study

TABLE 6

Summary of Results

Unit	Required Capability	Computed Capability
MASH	100%	43%
CSH	35%	24%
FLD	20%	25%

Another factor to be considered for the FLD and CSH is the amount of cargo capacity provided by MILVANs, 1 to 2 Expandables, and 1 to 3 Expandables (the MASH has no containers). These containers are essentially intended for one-way trips not multiple round trips between sites (container capacity is included in Table 6 calculations). Only the large trucks (2.5 Ton, 5 Ton and larger) and 1.5 Ton Trailers are practical for multiple trips so useable cargo capacity is actually less than the overall figures indicate (3/4 Ton and 1.25 Ton trucks are not significant). Table 7, below, displays the lift capacity of the trucks compared to the cargo in excess of the containers' capacity (seating and weight for personnel is not included).

As shown in Table 7, the reusable capacity of the units is 28 percent for the CSH and 31 percent for the FLD. It is unknown how many personnel would have to be accommodated on each trip, but they would drive the computed capacity lower than the Table 6 figures. This reinforces the finding that the CSH fails to meet doctrinal requirement. The MASH is not shown in Table 7 because the studied version included no containers.

TABLE 7

Vehicles and Non-containerized Cargo

Unit	Truck Capacity	Excess Cargo	Computed Capacity
CSH	14930 cf	53451 cf	28 %
	265500 lbs	613859 lbs	43 %
FLD	9305 cf	29628 cf	31 %
	168000 lbs	457447 lbs	37 %

Recommendations

Recommendations based on research. Transportation assets for two units are not sufficient to meet their doctrinal mobility requirements. It is suspected that if all factors were considered, the FLD would also fail to meet its requirement. In addition, the doctrinal requirements may be too low to allow sufficient mobility on a mid-intensity battlefield that may require movement of the units, particularly the MASH and CSH, every three to five days. Based on study of the Korean War, Vietnam War, and Grenada movement requirements fall in the two extremes very frequent or almost permanent stationing. Simply put, the units need more vehicles to conform to doctrine and for survival in a mobile battlefield, or only sustainment vehicles are needed if bases are semi-permanent.

It may be more efficient for the vehicles of the CSH and FLD to be removed from the units (except for supply sustainment vehicles) and consolidated at the Medical Group or Medical Brigade level in a dedicated transportation platoon. This platoon could then be dispatched to the hospitals when required. The MASH doctrinal requirement to operate in both the Corps Support Area and the Division Area may preclude removal of its trucks.

This consolidation is implied by MEDFORCE 2000 doctrine (AHS Paper, 1989:1-8). Consolidation would require the assignment of dedicated drivers which would increase the efficiency of logistics and medical personnel in the CSH and FLD by relieving them of driving and maintenance duties which detract from their normal duties. It would also be more efficient for the 2.5 Ton and 5 Ton trucks to be traded for semi-trailers and tractors which would greatly increase capacity with no increase in personnel. Some maintenance personnel at the CSH and FLD could also be consolidated at the higher level with the trucks. Conversations with DEPMEDS equipped units have confirmed evaluation studies that the 7.5 Ton Dolly is only marginally useful and that a 50000 Pound Container Handler is essential for timely and accurate erection of the hospitals when equipped with the MILVAN style containers. It might not be cost effective to assign one of these items to each hospital, but one or two could be effectively controlled at the Group or Brigade level with the consolidated truck fleet. Use of the container handlers in conjunction with the semi-trailers (which can carry two MILVANs or Expandables) would increase overall mobility. Another reason to consolidate the vehicles at a higher level is the probability that low intensity conflicts will predominate. These wars (such as Vietnam or late Korea) have seen the hospitals essentially convert to immobile station hospitals in fixed cantonments. Centralized vehicle assets could be maintained in lower quantities than if dispersed in the scattered units.

Whether or not vehicles are consolidated at a higher level, greater use should be made of semi-trailers with tractors in exchange for fewer 5 Ton Trucks. The only significant weakness of the longer trucks is a wider turning radius and there are many offsetting positive factors all equating to greater efficiency. Semi-trucks are already used by divisional and corps units for

resupply operations forward to the Brigade Trains area. In units with less than a 100 percent mobility requirement, there could be fewer tractors than trailers. For example one tractor with two water tanker trailers could more efficiently supply the hospital than several 2.5 Ton water trucks and water trailers. The use of a similar system for fuel would be more efficient than the current 5 Ton truck with a Tank and Pump Unit. Long flatbed trailers (40 feet) would transport MILVANs and Expandables more efficiently than 7.5 Ton Dollies. Some 2.5 Ton and 5 Ton trucks must be retained for personnel transport or other low density requirements.

Another weak link in mobility (upon examination of the authorization documents) is the lack of sufficient communications equipment and personnel. Communications are required for the day-to-day operation of the hospitals, security, and convoy control. During a unit move it would be necessary for the unit to maintain (assuming a multi-lift move) communications at the old and new sites and with the convoys between the sites. At a minimum, this would require an FM band (Frequency Modulation) radio and antennas at the two sites and at least three mobile FM radios and antennas with each convoy. The units do not have this capability and it is unlikely that radios could be borrowed in battle when everything is in short supply.

Recommendations based on the author's opinion. Several other weaknesses in organizational structure and equipment contribute to reduced mobility by slowing erection time at new sites. The author's opinion is often confirmed by official evaluations.

First, the equipment requires lighted conditions to assemble and erect, particularly the FLD and CSH. Daylight may not be available in some latitudes or time limits may require erection at night. Assuming blackout conditions can be

violated, tying up the units vehicle headlights to light the area would reduce mobility. The best solution is to equip the hospitals with several portable flood light units which could be used not only for night erection but also outdoor night Triage, maintenance, and perimeter security.

Second, the hospitals are dependent on extensive engineer site preparation prior to equipment erection (ATTE-3, 1988:2-58). Without a prepared site the unit is effectively immobile because it has no place to move to. Hospitals require firm, level, drained sites for their equipment. Expandables require relatively level ground and the TEMPER tents absolutely require level ground (ATTE-3, 1988:2-59). Outside of sports fields and airfield aprons, these pre-existing conditions are usually hard to find. Effective drainage and soil compaction is required to prevent the hospital site from becoming a quagmire in wet conditions. Hospitals require large amounts of water for staff and patient support. The current hospitals do not have effective water distribution or storage systems as part of their equipage. Linked to water usage is the need for sewage collection and disposal. The units do not have a sewage collection and disposal system and soakage pits would not be effective for more than a few hours or days under true operational conditions (ATCD-8, 1977:C-6 and ATTE-3, 1988:2-59). All of this means the engineers, with heavy equipment, would require several days to prepare the site prior to the unit's arrival and several days after erection to complete site water and sewage systems. It is unlikely the engineers have this time under combat conditions when they are dedicated to mobility, counter-mobility, and barrier operations. Hospitals also require good access roads and heliports for sustained operations.

It is recommended that the hospitals be equipped with one or more 5 Ton Dump Trucks (daily use as trash trucks), a bulldozer (tracked or wheeled), and a

multipurpose tractor with front scoop loader and backhoe or trencher (ATTE-3, 1988:2-59). These items of unit equipment would not only be useful to assist the engineers during site preparation of roads, trenches (for fuel, electric, water and sewage lines) and defense positions, but also to manage the large and continuous garbage removal problem and maintenance of the unit area. It is unrealistic to assume that other units will take care of the hospitals' disposal problems, particularly in new undeveloped theaters.

Visits with DEPMEDS and MUST equipped units have revealed concern about the lack and type of storage space for equipment and supplies and the poor access to supplies and damage to supplies stored in MILVANs (also a finding during the DEPMEDS 8th Evacuation Hospital Test [ATTE-3, 1988:2-64]). Units also complained that they had to use leased containers to make up the shortfall between the storage requirement for equipment shipped to them and storage containers provided. The DEPMEDS concept has made a large step forward in use of International Standards Organization (ISO) standards for hospital containers. This partially accomplishes the recommendations of the Joint Logistics Review Board to exploit containerization (JLRB, 1969:63).

Containerization can be implemented to a greater extent. Currently, there are too few containers for the hospital supply section to operate from the MILVANs, instead tents must be set-up and supplies moved out of containers and into tents. This means double handling. MILVANs also offer better environmental protection compared to tents, particularly against dirt, rain, sand, snow, and for security. Shelving and restraint systems should be permanently mounted in MILVANs dedicated to supply use. This would reduce handling and damage, plus provide for fast set up and efficient supply issues (ATTE-3, 1988:2-55).

If containers were properly organized and stocked in a standard manner, resupply could be accomplished by exchanging the container in the same manner that cart exchange systems are run in fixed hospitals. Push systems of resupply are expected to be the initial standard in future conflicts. However, push systems are recognized as very wasteful compared to pull systems. Container exchange would allow an efficient push system without the waste normally encountered in push systems. Containers could be packed at US depots and shipped overseas or in mature theaters they could be packed/replenished at Medical Supply, Optical and Maintenance units (MEDSOM) and recycled. Push/Exchange could also be accomplished with the proposed Palletized Loading System (PLS) provided closed securable vans are part of the system. Fielding of the PLS is not a confirmed option due to a skeptical Congress and current (1990) initiative to cut funds (Cappaccio, 1987:13). Containerization can extend to more than medical supplies to include food, clothing, and other items.

Items that are temperature sensitive (hot or cold) should be containerized in insulated ISO containers that have heatpumps (dual mode heating and cooling) to maintain the proper temperature range. Because these containers are self-contained and better insulated than tents, heater fuel requirements would be reduced and it would eliminate the use of maintenance intensive 600 Cubic Feet knockdown refrigerators (ATCD-8, 1977:C-5 and ATTE-3, 1988:2-64). Heatpump units are available that operate on either fuel or electricity.

Summary of Recommendations

Units need more vehicles and/or a different transportation organization and equipment to meet the doctrinal mobility requirements. The 7.5 Ton Dolly should be replaced by container chassis or flatbed semi-trailers as prime

mobilizers for the MILVANs and Expandables. Container handlers need to be assigned to hospitals or their controlling headquarters.

Units need greater and improved means to control the movement of convoys between sites and keep the old and new sites in communication.

Addition of night lighting equipment (assuming blackout conditions can be violated) would increase the usable erection time for equipment and free trucks to move equipment.

If the first three problems are solved, the unit still needs a prepared location to move to.and sustaining utilities and services at the new site. Competition with other units and missions for scarce engineer unit resources would probably leave the hospitals low on the priority list and without a prepared or sustainable site. The addition of minimal engineer earth construction equipment and operators to the unit authorizations would allow the unit to assist engineers during site preparation and to perform the continuous site maintenance and garbage disposal requirements after the engineers depart.

Containerization needs to be increased.

Overall Summary of Research

Two of the three units, the CSH and MASH, do not meet the minimum transportability requirement established in the MEDFORCE 2000 doctrine. If the FLD were examined with the inclusion of all cargo and personnel loading inefficiencies it might not conform to doctrine.

The units need more vehicles and/or a different transportation organization and equipment to meet the doctrinal mobility requirements and learn from historical experience. Even if provided sufficient vehicles,

additional communications equipment is required for convoy control and security.

More extensive use should be made of containers and containerization.

Inextricably connected to unit movement is site preparation. The entire site preparation, set-up, and area utilities and maintenance requirement is a weak link and would probably prevent rapid establish and functioning of a truly operational hospital. Additional equipment and manpower is required to provide site preparation and sustainment for the hospitals.

Future research should be conducted in the area of ground tactical movements. First, the area of packing inefficiencies could be investigated. Utility of vehicle capacity is poorly understood in detail and various shape, weight, unit integrity, and regulatory restrictions on achieving high utilization are scattered in many publications or nonexistent. Second, further enhancement of the DSS can be made to incorporate data update screens for the data files, the program could be compiled to negate the requirement for DBASEIII+ to be resident in the computer, and users could be surveyed to determine further improvements. Third, the DSS could be enhanced so it could perform calculations and make reports and recommendations for other modes of transport such as rail, air, and water. Fourth, a total logistical requirements study could be made to support and recommend modification of unit structure and addition/deletion of personnel and equipment so the hospitals could set-up and perform sustained operations. Last, the concept of a container exchange push or pull resupply system should be studied.

Appendix A

MASH UNIT EQUIPMENT LIST
(WEIGHT AND CUBE COMPUTED)

MOBILE ARMY SURGICAL HOSPITAL (MASH) TOE 08-763L

(Appendix A is an electronic data supplement to the thesis. It is contained in disk file MASHOUT.TXT)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

(MASHOUT.TXT is created by program MASHGRAB.PRG combining files MASH763L.DBF and LINDAT.DBF)

(File Information Structure with sample information.)

LIN	NOMENCLATURE	UI	QTY	UI WGHT	UI CUBE
	LINE WGHT	LINE CUBE	SOURCE	NOTES	
99003N	TYPEWRITER MANUAL	EA	1	34.00	2.00
	34.00	2.00	CTA		
B14729	PERSONNEL BAGGAGE	EA	8	60.00	7.00
	480.00	56.00	CTA		
BARBWIR	CONCERTINA WIRE 50ft	RL	18	38.00	3.00
	684.00	54.00	CTA		
C68719	CABLE TEL:WD-1 1/2 KM	RL	3	12.00	0.40
	36.00	1.20	TOE		

Appendix B

COMBAT SUPPORT HOSPITAL EQUIPMENT LIST
(WITH WEIGHT AND CUBE COMPUTED)

COMBAT SUPPORT HOSPITAL TOE 08-705L1

(Appendix B is an electronic data supplement to the thesis. It is contained in disk file CSHOUT.TXT)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

(CSHOUT.TXT is created by program CSHGRAB.PRG combining files CSH705L.DBF and LINDAT.DBF)

(File Information Structure with sample information)

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LIN      NOMENCLATURE              UI  QTY  UI WGHT   UI CUBE
         LINE WGHT  LINE CUBE  SOURCE  NOTES
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             68.00      4.00       CTA

B14729  PERSONNEL BAGGAGE         EA   14   60.00     7.00
            840.00     98.00       CTA

BARBWIR CONCERTINA WIRE 50ft      RL   18   38.00     3.00
            684.00     54.00       CTA

C68719  CABLE TEL:WD-1 1/2 KM     RL    4   12.00     0.40
             48.00      1.60        TOE
```

Appendix C

FIELD HOSPITAL EQUIPMENT LIST
(WEIGHT AND CUBE COMPUTED)

FIELD HOSPITAL TOE 08-715L

(Appendix C is an electronic data supplement to the thesis. It is contained in disk file FLDOUT.TXT)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

(FLDOUT.TXT is created by program FLDGRAB.PRG combining files FLD715L.DBF and LINDAT.DBF)

(File Information Structure with sample information)

```
LIN     NOMENCLATURE              UI  QTY  UI WGHT  UI CUBE
            LINE WGHT  LINE CUBE  SOURCE  NOTES
=================================================================

99003N  TYPEWRITER MANUAL       EA   2    34.00     2.00
             68.00       4.00      CTA

B14729  PERSONNEL BAGGAGE       EA   14   60.00     7.00
            840.00      98.00      CTA

BARBWIR CONCERTINA WIRE 50ft RL  18   38.00     3.00
            684.00      54.00      CTA

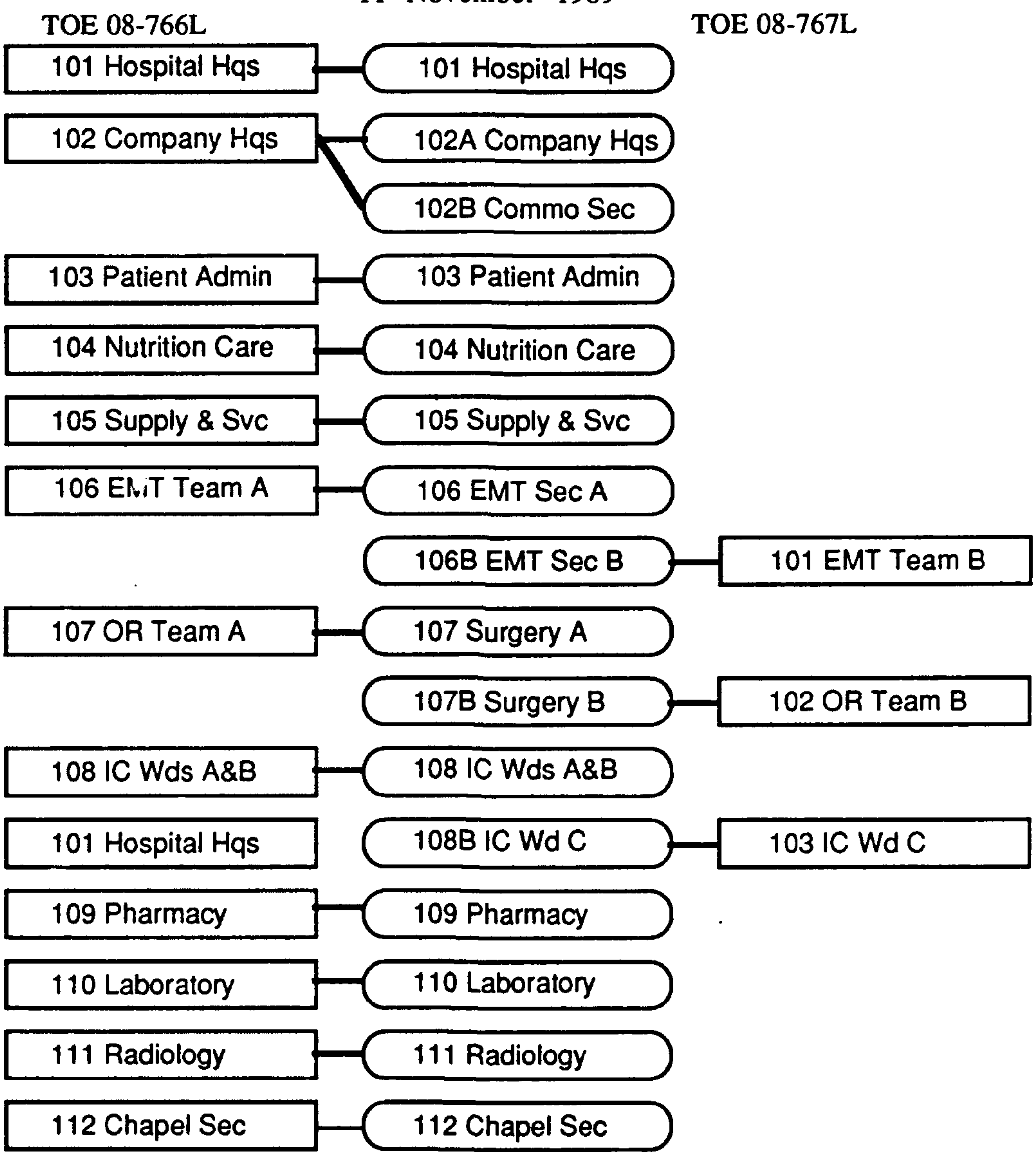
C68719  CABLE TEL:WD-1 1/2 KM  RL   4    12.00     0.40
             48.00       1.60      TOE

CHAIRFL CHAIRS, FLDG            EA   14   10.00     3.00
            140.00      42.00      CTA
```

Appendix D

MASH Structure

TOE 08-763L
11 November 1989



Appendix E

Combat Support Hospital Structure

TOE 08-736L1	TOE 08-705L1	TOE 08-737L
101 Hospital Hqs	101 Hospital Hqs	
	101B Hospital Hqs B	101 Unit Hqs
102 Ops Sec	102A Operations Sec	
	102B Commo Sec	
103 Company Hqs	103 Company Hqs	
104 Admin Sec	104 Admin Sec	
105 Patient Admin	105 Patient Admin	
106 Nutrition Care	106 Nutrition Care	
107 Supply & Svc	107 Supply&Svc A	
	107B Supply&Svc B	102 Supply&Svc
108 Nurs Ctrl Tm	108 Nurs Ctrl Tm	
109 Triage/EMT	109 EMT Sec A	
	109B EMT Sec B	104 Triage/EMT
110 Litter Bearer	110 Litter Bearer	
111 OR/CMS Cntrl	111 OR/CMS Cntrl A	
	111B OR/CMS Cntrl B	103 OR/CMS Cntrl
112 Operating Rm A	112 Surgery Tm A	
113 Operating Rm B	113 Surgery Tm B	
	113B Surgery Tm C	105 Operating Rm C
	113C Surgery Tm D	106 Operating Rm D

Combat Support Hospital Structure (continued)

TOE 08-736L1	**TOE 08-705L1**	TOE 08-737L
114 Ortho Cast Clinic	114 Ortho Cast Tm A	
	114B Ortho Cast Tm B	107 Ortho Cast Clinic
115 CMS 1 & 2	115 CMS 1 & 2	
	115B CMS 3 & 4	108 CMS 1 & 2
116 Dental Svc	116 Dental Svc	
117 Inpatient Med A	117 Inpatient Med A	
118 IntCare Wds 1-3	118A IC Wds 1-3	
	118B IC Wds 4-8	109 IC Wds 1-5
119 IM Cr Wds 9-15	119 IM Wds 9-15	
120 NP Ward&Consl	120 NP Ward&Consl	
121 Min Cr Wds 2	121 Min Cr Wds 2	
122 Pharmacy Svc	122 Pharmacy Tm	
123 Laboratory Svc	123 Laboratory Sec	
124 Blood Bank	124 Blood Bank Sec	
125 Radiology Svc	125 Radiology Sec A	
	125B Radiology Sec B	110 Radiology Svc
126 Phys Therpy Svc	126 Phys Therpy Sec	
127 Hosp Ministry	127 Chapel Sec	

Current 16 November 1989

Appendix F

Field Hospital Structure

TOE 08-736L2	TOE 08-715L	TOE 08-739L
101 Hospital Hqs	101 Hospital Hqs	
	101B Hospital Hqs	101 Unit Hqs
102 Operations Sec	102A Operations	
	102B Commo Sec	
103 Company Hqs	103 Company Hqs	
104 Admin Sec	104 Admin Sec	
105 Pat Admin Sec	105 Pat Admin Sec	
106 Nutrition Care	106 Nutrition Care	
107 Supply & Svc	107 Supply & Svc	
	107B Supply&Svc	102 Supply&Svc
108 Nursing Ctrl Tm	108 Nursing Ctrl	
109 Triage /EMT	109 EMT Sec A	
	109B EMT Sec B	103 Clinical Svc
110 OR/CMS Ctrl Tm	110 OR/CMS Ctrl	
111 Operating Rm A	111 Surgery A	
112 Operating Rm A	112 Surgery B	
113 Ortho Cast Clinic	113 Ortho Cast	
114 CMS 1 & 2	114 CMS 1 & 2	
115 Dental Sec	115 Dental Sec	
116 InPatient Med A	116 InPat Med A	

Field Hospital Structure (continued)

TOE 08-736L	**TOE 08-715L**	TOE 08-739L
117 Int Cr Ward 1-3	117A IC Ward 1-3	
118 Im Care Wds	118 IM Ward 4-10	
119 NP Wd &Cons	119 NP Wd &Cons	
120 Min Care Wds	120 Min Wd 12-13	
	120B Min Wd 14-20	104 Min Care Wds
121 Pharmacy	121 Pharmacy	
122 Laboratory	122 Laboratory	
123 Blood Bank	123 Blood Bank	
124 Radiology	124 Radiology	
125 Phys Thpy	125 Phys Thpy A	
	125B Phys Thpy B	105 Phys Thpy
126 Chapel	126 Chapel	

Current 2 January 1990

Appendix G

Main Decision Support System Program

(Appendix G is an electronic data supplement to the thesis. It is contained in disk file DSSMAIN1.PRG)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

Appendix H

Mobile Army Surgical Hospital Program Module

(Appendix H is an electronic data supplement to the thesis. It is contained in disk file DSS1.PRG)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

Appendix I

Mobile Army Surgical Hospital Program Example Results

UNIT: MOBILE ARMY SURGICAL HOSPITAL
MISSION: COMBAT or COMBAT TRAINING
MINIMUM TEMPERATURE: 45 DEGREES FAHRENHEIT 7 DEGREES CELSIUS
TOTAL UNIT PERSONNEL STRENGTH: 132
DATE: 29- 6-1990 **TIME:** 00:07:38

MOVEMENT SCHEDULE:

SECTION	LIFT 1	LIFT 2	LIFT 3
Headquarters	1	0	0
Company Headquarters	1.0	0.0	0.0
Communications Section	1	0	0
Patient Admin Section	1.0	0.0	0.0
Nutrition Care	1	0	0
Logistics	1.0	0.0	0.0
EMT Section A	1	0	0
EMT Section B	1	0	0
Surgery A	1	0	0
Surgery B	1	0	0
Intensive Care Ward A	1	0	0
Intensive Care Ward B	1	0	0
Intensive Care Ward C	1	0	0
Pharmacy	1	0	0
Laboratory	1	0	0
X-Ray Section	1	0	0
Chapel Section	1	0	0
TOTAL Cargo Weight	197951	0	0
TOTAL Cargo Cubic Ft	15924	0	0
TOTAL Personnel	132	0	0

TRANSPORT ASSETS:

Assets		Towed Loads
3/4 Ton Truck:	1	
5/4 Ton Truck:	3	3 : 3/4 Ton Size Trailers
2.5 Ton Truck:	9	11 : 1.5 Ton Size Trailers
5 Ton Truck:	8	0 : 7.5 Ton Dollies
3/4 Ton Trailers:	3	
1.5 Ton Trailers:	9	
Water Trailers :	1	
Kitchen Trailer:	1	
7.5 Ton Dollies:	0	
MILVANS/EXPANDOs:	0	
MILVANS:	0	
EXPANDO 1 to 2:	0	
EXPANDO 1 to 3:	0	
40 PAX Bus:	0	
S&P Semi-Truck:	0	

COMPUTATIONS:

CATEGORY	LIFT 1	LIFT 2	LIFT 3
Seats Required	132	0	0
Seats Available	254	254	254
Seats Over/Short	122	254	254
Equipment CF Req	15924	0	0
Available CubeFt	3850	7550	7550
CF Short/Over	-12074	7550	7550
Equipment Lbs Req	197951	0	0
Available Lbs Cap	70000	125000	125000
Lbs Short/Over	-127951	125000	125000

Note 1: Personnel seating given priority over cargo space.
Note 2: 2.5 Ton Truck given preference vs 5 Ton Truck for personnel.
Note 3: Personnel loading inefficiencies reduce cargo space.

Appendix J

Field Hospital Program Module

(Appendix J is an electronic data supplement to the thesis. It is contained in disk file DSS2.PRG)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

Appendix K

Field Hospital Program Example Results

UNIT: FIELD HOSPITAL
MISSION: COMBAT or COMBAT TRAINING
MINIMUM TEMPERATURE: 45 Degress Fahrenheit 7 Degrees Celsius
TOTAL UNIT PERSONNEL STRENGTH: 440
DATE: 28- 6-1990 **TIME:** 23:55:03

MOVEMENT SCHEDULE:

SECTION	LIFT 1	LIFT 2	LIFT 3	LIFT 4	LIFT 5
Headquarters Section A	1.0	0.0	0.0	0.0	0.0
Headquarters Section B	1.0	0.0	0.0	0.0	0.0
Operations Section	1.0	0.0	0.0	0.0	0.0
Communications Section	1.0	0.0	0.0	0.0	0.0
Company Headquarters	1.0	0.0	0.0	0.0	0.0
Administrative Section	1.0	0.0	0.0	0.0	0.0
Patient Admin Section	1.0	0.0	0.0	0.0	0.0
Nutrition Care Section	1.0	0.0	0.0	0.0	0.0
Supply & Service Section A	1.0	0.0	0.0	0.0	0.0
Supply & Service Section B	1.0	0.0	0.0	0.0	0.0
Nursing Control Team	1.0	0.0	0.0	0.0	0.0
Emergency Medicine Team A	1.0	0.0	0.0	0.0	0.0
Emergency Medicine Team B	1.0	0.0	0.0	0.0	0.0
OR/CMS Control Team	1.0	0.0	0.0	0.0	0.0
Surgery Team A	1.0	0.0	0.0	0.0	0.0
Surgery Team B	1.0	0.0	0.0	0.0	0.0
Orthopedic Cast Section	1.0	0.0	0.0	0.0	0.0
Central Material Sec 1 & 2	1.0	0.0	0.0	0.0	0.0
Dental Section	1.0	0.0	0.0	0.0	0.0
In-Patient Medicine Section	1.0	0.0	0.0	0.0	0.0
Intensive Care Wards 1-3	1.0	0.0	0.0	0.0	0.0
Intermediate Cr Wards 4-10	1.0	0.0	0.0	0.0	0.0
Neuro Psych Ward & Consult	1.0	0.0	0.0	0.0	0.0
Minimal Care Wards 12-13	1.0	0.0	0.0	0.0	0.0
Minimal Care Wards 14-20	1.0	0.0	0.0	0.0	0.0

MOVEMENT SCHEDULE (continued):

SECTION	LIFT 1	LIFT 2	LIFT 3	LIFT 4	LIFT 5
Pharmacy Section	1.0	0.0	0.0	0.0	0.0
Laboratory Section	1.0	0.0	0.0	0.0	0.0
Blood Bank Section	1.0	0.0	0.0	0.0	0.0
Radiology Section	1.0	0.0	0.0	0.0	0.0
Physical Therapy Section A	1.0	0.0	0.0	0.0	0.0
Physical Therapy Section B	1.0	0.0	0.0	0.0	0.0
Chapel Section	1.0	0.0	0.0	0.0	0.0
TOTAL Cargo Weight	763947	0	0	0	0
TOTAL Cargo Cubic Ft	58172	0	0	0	0
TOTAL Personnel	440	0	0	0	0

TRANSPORT ASSETS:

ASSETS		TOWED LOADS
1/4 Ton Truck:	0	0 : 1/4 Ton Size Trailers
3/4 Ton Truck:	3	Not Recommended for 3/4 Ton Trailers
5/4 Ton Truck:	3	3 : 3/4 Ton Size Trailers
2.5 Ton Truck:	0	4 : 1.5 Ton Size Trailers
5 Ton Truck:	17	35 : 7.5 Ton Dollies or 100KW Generators
5 Ton Wrecker:	0	
Water Truck 1000GL:	0	
1/4 Ton Trailers:	0	
3/4 Ton Trailers:	3	
1.5 Ton Trailers:	1	
Water Trailers :	3	
Kitchen Trailers:	0	
Laundry Trailers:	0	
100 KW Generators:	7	
7.5 Ton Dollies:	28	
MILVANS/EXPANDOs:	29	
MILVANS:	19	
EXPANDO 1 to 2:	5	
EXPANDO 1 to 3:	5	
Fork Lift 4000 LB:	2	
40 PAX Bus:	0	
S&P Semi-Truck:	0	

Note 1: 5 Ton Truck can tow 1.5 Ton Trailer.
Note 2: Water Truck not recommended for cross-country with full load.
Note 3: Water Truck (with water) not recommended to tow trailer.
Note 4: Wrecker or desiginated recovery vehicle should not tow trailer
Note 5: POL Tank & Pump Unit requires a dedicated 5 Ton Truck.

COMPUTATIONS:

CATEGORY	LIFT 1	LIFT 2	LIFT 3	LIFT 4	LIFT 5
Seats Required	440	0	0	0	0
Seats Available	287	287	287	287	287
Seats Over/Short	-153	287	287	287	287
Equipment CF Req	58172	0	0	0	0
Available CubeFt	0	0	0	0	0
CF Short/Over	-58172	0	0	0	0
Equipment Lbs Req	763947	0	0	0	0
Available Lbs Cap	0	0	0	0	0
Lbs Short/Over	-763947	0	0	0	0

Note 1: Seating given priority over cargo space in calculations.
Note 2: 2.5 Ton Truck given preference vs 5 Ton Truck for personnel.
Note 3: Personnel loading inefficiencies reduce available cargo space.

Appendix L

Combat Support Hospital Program Module

(Appendix L is an electronic data supplement to the thesis. It is contained in disk file DSS3.PRG)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

Appendix M

Combat Support Hospital Program Example Results

UNIT: COMBAT SUPPORT HOSPITAL
MISSION: COMBAT or COMBAT TRAINING
MINIMUM TEMPERATURE: 45 Degress Fahrenheit 7 Degrees Celsius
TOTAL UNIT PERSONNEL STRENGTH: 599
DATE: 28- 6-1990 **TIME:** 23:32:16

MOVEMENT SCHEDULE:

SECTION	LIFT 1	LIFT 2	LIFT 3	LIFT 4	LIFT 5
Headquarters Section A	1.0	0.0	0.0	0.0	0.0
Headquarters Section B	1.0	0.0	0.0	0.0	0.0
Operations Section	1.0	0.0	0.0	0.0	0.0
Communications Section	1.0	0.0	0.0	0.0	0.0
Company Headquarters	1.0	0.0	0.0	0.0	0.0
Administrative Section	1.0	0.0	0.0	0.0	0.0
Patient Admin Section	1.0	0.0	0.0	0.0	0.0
Nutrition Care Section	1.0	0.0	0.0	0.0	0.0
Supply & Service Section A	1.0	0.0	0.0	0.0	0.0
Supply & Service Section B	1.0	0.0	0.0	0.0	0.0
Chapel Section	1.0	0.0	0.0	0.0	0.0
Emergency Medicine Team A	1.0	0.0	0.0	0.0	0.0
Emergency Medicine Team B	1.0	0.0	0.0	0.0	0.0
Litter Team	1.0	0.0	0.0	0.0	0.0
In-Patient Medicine Section	1.0	0.0	0.0	0.0	0.0
OR/CMS Control Team A	1.0	0.0	0.0	0.0	0.0
OR/CMS Control Team B	1.0	0.0	0.0	0.0	0.0
Surgery Team A	1.0	0.0	0.0	0.0	0.0
Surgery Team B	1.0	0.0	0.0	0.0	0.0
Surgery Team C	1.0	0.0	0.0	0.0	0.0
Surgery Team D	1.0	0.0	0.0	0.0	0.0
Orthopedic Cast Section A	1.0	0.0	0.0	0.0	0.0
Orthopedic Cast Section B	1.0	0.0	0.0	0.0	0.0
Central Material Sec 1 & 2	1.0	0.0	0.0	0.0	0.0

MOVEMENT SCHEDULE (continued):

SECTION	LIFT 1	LIFT 2	LIFT 3	LIFT 4	LIFT 5
Central Material Sec 3 & 4	1.0	0.0	0.0	0.0	0.0
Dental Section	1.0	0.0	0.0	0.0	0.0
Pharmacy Section	1.0	0.0	0.0	0.0	0.0
Laboratory Section	1.0	0.0	0.0	0.0	0.0
Blood Bank Section	1.0	0.0	0.0	0.0	0.0
Radiology Section A	1.0	0.0	0.0	0.0	0.0
Radiology Section B	1.0	0.0	0.0	0.0	0.0
Physical Therapy Section	1.0	0.0	0.0	0.0	0.0
Nursing Control Team	1.0	0.0	0.0	0.0	0.0
Intensive Care Wards 1-3	1.0	0.0	0.0	0.0	0.0
Intensive Care Wards 4-8	1.0	0.0	0.0	0.0	0.0
Intermediate Care Wards 9-15	1.0	0.0	0.0	0.0	0.0
Neuro Psych Ward & Consult	1.0	0.0	0.0	0.0	0.0
Minimal Care Wards 16-17	1.0	0.0	0.0	0.0	0.0
TOTAL Cargo Weight	1013059	0	0	0	0
TOTAL Cargo Cubic Ft	90745	0	0	0	0
TOTAL Personnel	599	0	0	0	0

TRANSPORT ASSETS:

ASSETS		TOWED LOADS
1/4 Ton Truck:	3	3 : 1/4 Ton Size Trailers
3/4 Ton Truck:	0	Not Recommended for 3/4 Ton Trailers
5/4 Ton Truck:	2	1 : 3/4 Ton Size Trailers
2.5 Ton Truck:	1	10 : 1.5 Ton Size Trailers
5 Ton Truck:	25	46 : 7.5 Ton Dollies or 100KW Generators
5 Ton Wrecker:	1	
Water Truck 1000GL:	2	
1/4 Ton Trailers:	3	
3/4 Ton Trailers:	1	
1.5 Ton Trailers:	6	
Water Trailers :	2	
Kitchen Trailers:	0	
Laundry Trailers:	2	
100 KW Generators:	9	

TRANSPORT ASSETS (continued):

ASSETS		TOWED LOADS
7.5 Ton Dollies:	37	
MILVANS/EXPANDOs:	38	
MILVANS:	24	
EXPANDO 1 to 2:	7	
EXPANDO 1 to 3:	7	
Fork Lift 4000 LB:	2	
40 PAX Bus:	0	
S&P Semi-Truck:	0	

Note 1: 5 Ton Truck can tow 1.5 Ton Trailer.
Note 2: Water Truck not recommended for cross-country with full load.
Note 3: Water Truck (with water) not recommended to tow trailer.
Note 4: Wrecker or desiginated recovery vehicle should not tow trailer
Note 5: POL Tank & Pump Unit requires a dedicated 5 Ton Truck.

COMPUTATIONS:

CATEGORY	LIFT 1	LIFT 2	LIFT 3	LIFT 4	LIFT 5
Seats Required	599	0	0	0	0
Seats Available	423	423	423	423	423
Seats Over/Short	-176	423	423	423	423
Equipment CF Req	90745	0	0	0	0
Available CubeFt	0	0	0	0	0
CF Short/Over	-90745	0	0	0	0
Equipment Lbs Req	1013059	0	0	0	0
Available Lbs Cap	0	0	0	0	0
Lbs Short/Over	-1013059	0	0	0	0

Note 1: Seating given priority over cargo space in calculations.
Note 2: 2.5 Ton Truck given preference vs 5 Ton Truck for personnel.
Note 3: Personnel loading inefficiencies reduce available cargo space.

Appendix N

Transport Capacity Data File

(Appendix N is an electronic data supplement to the thesis. It is contained in disk file TRANSCAP.DBF)

Copies of electronic data supplements are available from the Air Force Institute of Technology, Attention: LSC, Wright-Patterson Air Force Base, Ohio, 45433-6583.

(File Information Structure with sample information.)

VEHICLE	QTY	CAPCUBE	CAPWEIGHT	CABSEATS	BEDSEATS	TOTCUBE	TOTWEIGHT	TOTCABSEAT	TOTBEDSEAT	NOTE1
1.5TONTRL	1	205	3000	0	0	205	3000	0	0	
1/4TONTRK	0	0	0	2	0	0	0	0	0	
1/4TONTRL	0	28	500	0	0	0	0	0	0	
1:2EXPAND	5	945	9500	0	0	4725	47500	0	0	
1:3EXPAND	5	865	8100	0	0	4325	40500	0	0	
2.5TONTRK	0	350	5000	2	11	0	0	0	0	

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Vita

Major James W. Ross was born February 7, 1952 in Salina, Kansas. His father, Lt Col Chester W. Ross (retired) was a career Air Force serviceman who served in many locales between 1942 and 1975 in both enlisted and officer ranks. James Ross was fortunate to attend schools in several states and overseas in England and Taiwan. He graduated from high school in 1970 at Bourne, Massachusetts, and college in 1974 at Colorado State University, Fort Collins, Colorado. James Ross was commissioned as a 2nd Lieutenant in the US Army Medical Service Corps (MSC) from the Army ROTC program in June 1974 and entered active duty as a Regular Officer 1 July 1974.

After completion of the officer basic course, his initial active duty assignment was to the 560th Ambulance Company at Uijongbu, South Korea performing the duties of Training Officer, Supply Officer, Executive Officer, and others. His second assignment was to the 3rd Battalion, 5th Infantry, Panama, as the Medical Platoon Leader and OIC Fort Kobbe Clinic. From 1976 to 1986 James Ross performed in various logistics positions in Panama, Korea, Thailand, California, and Virginia. His most recent assignment (1986-1989) was at Fort Irwin, California, as the construction project officer for three medical construction projects; a dental clinic, an outpatient clinic, and a major addition, repair,and upgrade to Fort Irwin's Weed Army Community Hospital. He was assigned to the graduate program School of Systems and Logistics, as the first US Army MSC officer student, in May 1989.

Major Ross has published two articles in *Army Logistician* magazine.

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
September 1990

3. REPORT TYPE AND DATES COVERED
Master's Thesis

4. TITLE AND SUBTITLE
STUDY OF VEHICLE TRANSPORTATION REQUIREMENTS FOR HOSPITALS AT THE CORPS LEVEL

5. FUNDING NUMBERS

6. AUTHOR(S)
James W. Ross, Major, USA

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Institute of Technology
WPAFB OH 45433-6583

8. PERFORMING ORGANIZATION REPORT NUMBER
AFIT/GLM/LSM/90S-46

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
"Approved for public release; distribution unlimited."

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
This thesis examines ground vehicle transportation requirements for the three significant hospitals in support of the deployed Corps. A computer assisted Decision Support System was developed to calculate the relationship between vehicle transportation requirements and assets (requires DBaseIII+). Under MEDFORCE 2000 doctrine, these hospitals are the Combat Support Hospital (CSH), Field Hospital (FLD), and Mobile Army Surgical Hospital (MASH). Doctrine requires these hospitals to contain internal (organic) transportation assets to lift a percentage of their equipment and personnel in a single lift (MASH-100%, CSH-35%, FLD-20%). Unit structure developers (Table of Organization and Equipment) have not provided sufficient vehicles to transport two of the three units at the required level of mobility. Capabilities based on thesis research are: MASH-43%, CSH-24%, FLD-25%. Research was based on publicly available information from commercial and US Government sources. Historical study of field medical care was conducted with emphasis on Korea and Vietnam. Study was made of current doctrines governing US military ground forces in general and combat service support specifically; emphasis on Corps area hospitals. Official sources were used to quantify the transportation capabilities and requirements. Keywords:

14. SUBJECT TERMS
Corps Level Organization, Military Transportation, Land Transportation, Mobility, Hospitals, Combat Support, Theses. (SIU)

15. NUMBER OF PAGES
125

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT
Unclassified

18. SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. SECURITY CLASSIFICATION OF ABSTRACT
Unclassified

20. LIMITATION OF ABSTRACT
UL